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Evaluating the Success of Compensatory Wetland Mitigation in the California Coastal Zone

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This Master's Project

EVALUATING THE SUCCESS OF COMPENSATORY WETLAND MITIGATION IN THE CALIFORNIA COASTAL ZONE

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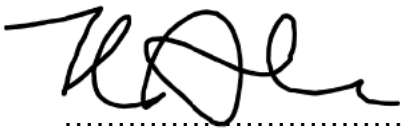 5/11/20			
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Abstract

Compensatory mitigation is a practice whereby a government agency requires the creation, restoration, enhancement, or preservation of ecological resources to offset unavoidable adverse impacts to environmentally sensitive habitat caused by some form of development. Compensatory wetland mitigation programs have slowed the rate of wetland loss in California and elsewhere, but they have largely failed to offset impacts with a sufficient amount of functional mitigation acreage. In California, more than 90% of the state's historical wetlands have been drained, diked, filled, or dredged over the past 100 years. This report evaluates the success of compensatory wetland mitigation required by the California Coastal Commission between 2012 and 2018. Methods involved reviewing permits and preparing a database to index all compensatory mitigation projects in the study period; locating all available mitigation plans and monitoring reports for those projects; statistically evaluating each project's compliance with performance criteria and "no net loss" policies; and performing a literature review to contextualize these findings. As permitted, the Coastal Commission's compensatory mitigation program appears to have resulted in a net gain of wetlands; however, incomplete monitoring data suggests that the net gain may be lower than reported. Fulfillment of performance criteria was about 70% as reported by annual monitoring reports from 20% of projects. Performance criteria focused mainly on vegetation. Requiring a more diverse range of criteria—including hydrology, soil, and wildlife-based metrics in addition to vegetation—could improve tracking of ecological function. This research also reveals opportunities to improve accountability through technical and procedural reforms, including maintaining a centralized storage system for mitigation monitoring data, requiring that compliance reports be reviewed by technical staff, encouraging clearer descriptions of mitigation requirements, and making compensatory mitigation data more accessible to the public.

1. Introduction

Compensatory mitigation is a practice whereby a government agency requires the creation, restoration, enhancement, or preservation of ecological resources to offset unavoidable adverse impacts to environmentally sensitive habitat caused by some form of development. The California Coastal Commission is a state agency that regulates development along the California coast. This report seeks to index, describe, and evaluate the success of compensatory wetland mitigation required for development projects permitted by the Coastal Commission between 2012 and 2018.

In order to contextualize the findings, this report reviews and summarizes relevant literature on the practice of compensatory wetland mitigation in California and further afield, including numerous case studies of performance criteria, mitigation success, monitoring thoroughness, and resultant ecological function. It also reviews the relevant policies of the California Coastal Act, the California Wetlands Conservation Policy, the U.S. Army Corps of Engineers Wetland Delineation Manual (1987 Manual and 2008 Arid West Supplement), and other guidelines and regulations forming the legal basis of compensatory mitigation in California. Where relevant, this paper also cites technical memoranda and permit language written by Coastal Commission staff.

The following introduction presents the study's research questions and provides background on the ecological context of wetland impacts as well as the practice of compensatory mitigation in the California Coastal Zone. Section 2, the literature review, synthesizes pertinent insights from peer-reviewed evaluations of compensatory wetland mitigation in other jurisdictions in order to contextualize the research vis-à-vis gaps in the existing literature. Section 3, Data and Methodology, describes the process of cataloging all compensatory mitigation required by the Coastal Commission between 2012 and 2018, then analyzing mitigation requirements for a subset of projects that had wetland and riparian impacts. Section 4, Analysis and Findings, includes summary tables, statistics, and other insights. Finally, Section 5, Conclusions and Recommendations, contains management recommendations designed to inform the ongoing evolution of the Coastal Commission's compensatory mitigation practice.

1.1 Research Question

The question at the core of this research project is: Has compensatory mitigation required by the California Coastal Commission since 2012 been successful in restoring lost wetland acreage and ecological function in the California Coastal Zone?

This main question is investigated through the following sub-questions:

1) Was there a net loss or a net gain of wetland acreage in the California Coastal Zone from the years 2012-2018?
2) Are there particular regions, habitat types, or mitigation strategies that have been more or less successful at mitigating losses of ecological function?
3) How thoroughly is the Coastal Commission monitoring permit compliance?

1.2 Ecological Context of Wetland Impacts

The ecological context for compensatory wetland mitigation in California is that more than 90% of the state's historical wetlands have been drained, diked, filled, or dredged for human development over the past 100 years (CSU Chico Dept. of Geography and Planning and Geographic Information Center, 2003). Agriculture has been a particularly significant driver of this trend statewide, although residential and commercial development projects have also contributed considerably to wetland loss, especially within the Coastal Zone. The U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory Status and Trends Report (1991) estimated that 53% of the pre-European wetland acreage in the conterminous United States had been converted to alternative land uses, from 221 million acres in the 1780s to 103 million remaining acres in the 1980s. This wetland destruction has continued into the 21st century, although there is evidence that the adoption of the federal No Net Loss policy in 1989—combined with the subsequent adoption of related state-level policies such as the California Wetlands Conservation Policy and the policies of the California Coastal Commission—has slowed the rate of wetland loss nationwide (USFWS 2020).

The National Resource Conservation Service defines three broad categories of wetlands: marine, tidal, and non-tidal. Marine wetlands exist in shallow coastal areas and are continuously submerged by ocean water, while tidal, or estuarine, wetlands occur in coastal areas inland from the shore. Non-tidal wetlands, which include 94% of the wetlands in the United States, occur inland, are fed by freshwater sources, and are not affected by tidal patterns (NRCS 2011). The Cowardin classification system, which is based primarily on vegetation cover and is used by the U.S. Fish and Wildlife Service among many other agencies, further subdivides nontidal (i.e., freshwater) wetlands into riverine (river), lacustrine (lake), and palustrine (marsh) categories (Federal Geographic Data Committee 2013). Since the California Coastal Zone contains a range of marine, tidal, and freshwater wetlands, the scope of this research includes all major types.

Wetlands perform a number of essential ecosystem services that sustain habitat functions and benefit human society, including carbon sequestration, filtration of pollutants from watershed runoff, storm protection, groundwater recharge, and erosion protection (USFWS 2020). They also provide habitat and food chain support for diverse species of birds, fish, mammals, invertebrates, and other taxa. Indeed, wetlands harbor a disproportionate number of threatened and endangered species. Of the 595 plant and animal species listed as threatened or endangered by the U.S. Fish and Wildlife Service in 1991, 43 percent were considered dependent on wetlands. (Flynn 1996). In 2019, data from the IUCN Red List of Threatened Species indicated that 25% of about 20,000 wetland-dependent species evaluated globally were endangered (Finlayson 2019).

The California coast is renowned for its biodiversity. The California Floristic Province, which encompasses about 70% of the state including the entire coastline, is one of 36 internationally recognized biodiversity hotspots (CEPF 2020). It is home to more than 5500 native plant taxa, including at least 2387 endemic species (Loarie et al. 2008). On the community scale, the coastal region is home to various rare vegetation alliances; according to the California Natural Diversity Database (CNDDB), 135 of the 280 vegetation types listed in the 1986 report “Preliminary Descriptions of the Terrestrial Natural Communities of California” are rare enough to justify protection and concern (Sawyer et al. 2009). In addition to providing habitat for a wide range of animal species year-round, California’s coastal wetlands are common stopover points for migratory

waterfowl and shorebirds traveling the Pacific Flyway (Engel 2010). This natural abundance makes coastal California an attractive setting for humans—it is the most populous region of the most populous state in the nation—but also a region navigating a delicate balance between conservation and development, with many taxa listed as endangered, threatened, or near threatened. A 1994 Coastal Commission report, "Procedural Guidance for the Review of Wetland Projects in California's Coastal Zone", counted 110 major coastal wetlands in the state. The wetlands in the northern counties are largely undeveloped, while those in the south are highly urbanized (Figure 1).

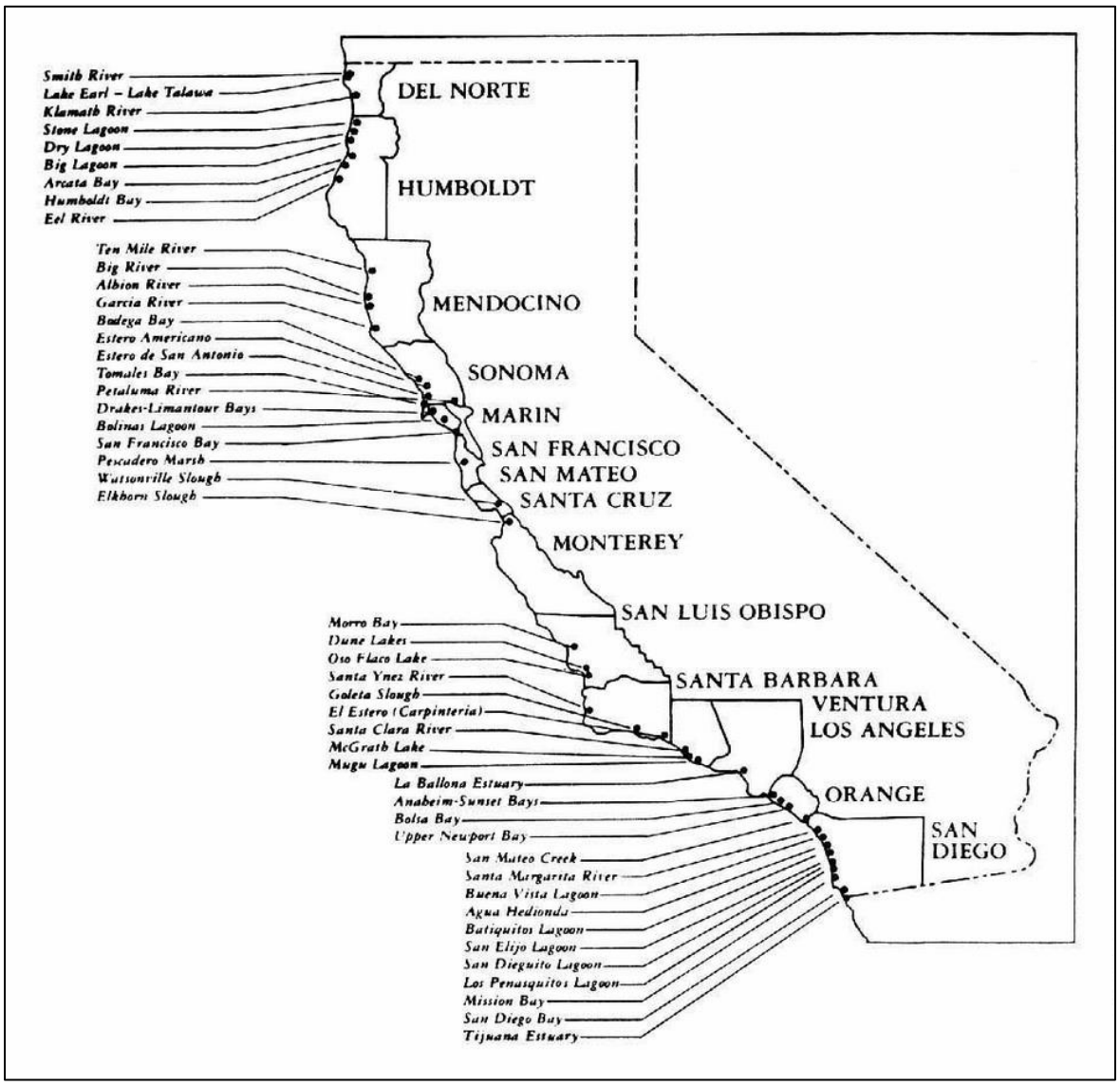

Figure 1: Major California Coastal Wetlands

Source: California's Coastal Wetlands, Institute of Marine Resources, 1979

Coastal wetlands in particular are highly vulnerable to the impacts of climate change even as they provide crucial protections for coastal communities (Zedler 2004). As sea levels rise, tidal wetland vegetation is forced to migrate upslope with the mean high-water mark, and so too must many associated wildlife species—much more quickly than has historically been the case when sea level rise took place over millennia. In areas backed by development, vegetation may have little space to migrate, causing it to fall victim to “coastal squeeze” and eventually drown. Furthermore, as stronger storm surges become more common in seaside communities, tidal wetlands are likely to be subjected to elevated salinity levels, debris fill, and other disturbances caused by extreme flooding events. Changing macroclimatic conditions such as temperature and precipitation regime are also predicted to drive foundational changes in vegetation community compositions, potentially enabling non-native species to become dominant and leaving these ecological transition zones less resilient to further rapid change (Osland et al., 2016). Rosencranz et al. (2019) projected that under a high (166 cm/100 year) sea level rise scenario, the extent of suitable salt marsh habitat in coastal California could increase somewhat by 2050, but then decrease by to 83% of current levels by 2100. These various potential impacts of anthropogenic climate change are likely to compound the existing vulnerability of coastal wetlands to destruction and degradation by direct human impacts, creating a more pressing need than ever to effectively protect and restore wetland areas.

Although coastal wetlands are vulnerable, they are also increasingly being touted as solutions to ameliorate the impacts of human development. Constructed wetlands are already used in some areas as a form of passive wastewater treatment, and natural or restored wetlands demonstrate a similar capacity for purification (Kurzbaum et al. 2012). In coastal areas, wetlands are being used as a design component of “living shorelines” which can provide natural, resilient attenuation of the effects of storms and sea level rise.

Suffice it to say that the wetlands of the California coast are unique, intricate, and threatened ecosystems with broad importance for humans, other species, and the earth systems that support us all. Compensatory mitigation is just one strategy for addressing wetland losses, but it is a powerful tool available to regulatory bodies seeking to

condition development projects to yield environmental benefits. By continuing to study and improve upon existing compensatory mitigation programs, by making monitoring requirements substantive and technical specifications ecologically meaningful, there is hope yet that we may begin to not only slow, but reverse some of the damage.

1.3 Compensatory Mitigation in the Coastal Zone

The California Coastal Commission is the primary state agency responsible for regulating development and protecting sensitive resources along the California coast. The California Coastal Act of 1972 is the statutory basis for the agency's authority and for preserving its natural resources. The Commission's spatial jurisdiction, which is called the California Coastal Zone, runs from Mexico to the Oregon border, and within that range extends an average of 1000 yards—and up to five miles at a maximum—inland from the mean high tide line as well as three nautical miles offshore to the state waters boundary (Figure 2). Altogether, this area comprises about 1.5 million acres of land area. The Coastal Commission's jurisdiction notably excludes the San Francisco Bay, which is regulated instead by the San Francisco Bay Conservation and Development Commission (BCDC).

Oversight of coastal development within the Coastal Zone is divided into six regional districts with offices in Eureka (North Coast), San Francisco (North Central Coast), Santa Cruz (Central Coast), Ventura (South Central Coast), Long Beach (South Coast), and San Diego (San Diego Coast). The Commission staff is headquartered in San Francisco and maintains an archive of agency records in Sacramento. Local Coastal Programs (LCPs)—local plans certified by the Commission as being consistent with the Coastal Act—enable the transfer of regulatory authority to sub-regional and municipal authorities throughout much of the Coastal Zone. In this way, LCPs replace the Coastal Act as the standard of review for localized planning. At the same time, the Commission retains its original jurisdiction in many areas that lack certified programs, and continues to hear appeals from throughout the Coastal Zone.

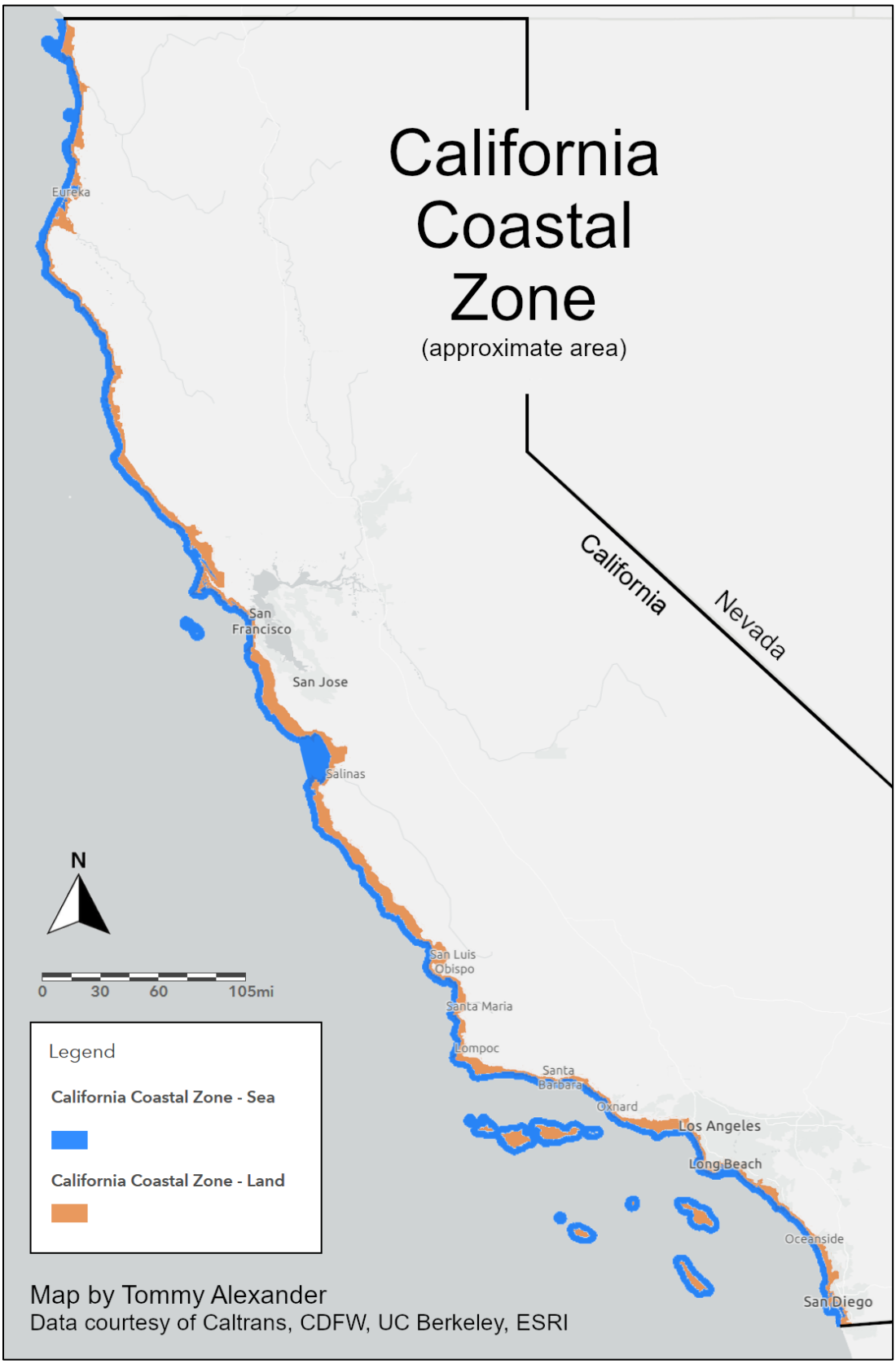

Figure 2: Map of the California Coastal Zone

The Commission itself is a quasi-judicial body made up of 12 voting members—appointed variously by the Governor, Senate Rules Committee, and Speaker of the Assembly—and three non-voting members: the chair of the State Lands Commission, the secretary of the Natural Resources Agency, and the secretary of the State Transportation Agency, or their appointed designees. The subset of 12 voting members includes six “public members” and six local elected officials from coastal districts. The Commission meets approximately once a month—rotating its meetings throughout the Coastal Zone districts—to consider the staff reports prepared for each coastal development permit application. The role of the staff is to handle the legal, technical, and administrative aspects of coastal planning, while the role of the commissioners is to adjudicate permit-related disputes, approve or deny permits based on staff recommendations, and adopt policies and implementation actions.

The Coastal Commission staff includes an Enforcement unit which responds to violations for unpermitted development and an Energy and Ocean Resources (EOR) unit which handles the permitting of large-scale energy infrastructure and offshore projects. Via the EOR unit, the agency has regulatory authority outside the Coastal Zone in cases where federal activities could affect resources within the Zone. This enables the agency to participate in the review process for projects that are, for instance, beyond the three-mile state waters boundary, or upstream from the Coastal Zone but located in the same watershed. Although the Commission’s jurisdiction is expansive, there are many activities within the Coastal Zone that are also regulated by other agencies, and projects often require approval from multiple agencies. For instance, the State Water Resources Control Board regulates water quality standards, the California Department of Fish and Wildlife has its own jurisdiction over biological resources, and the US Army Corps of Engineers has jurisdiction over federally-regulated wetlands. Each of these additional authorities is independent from the Coastal Commission, and their jurisdiction in the Coastal Zone, while complimentary, is generally more narrowly focused than that of the Commission.

The Coastal Commission uses a permitting process to regulate development projects in the Coastal Zone in compliance with the natural resource conservation and public access policies of the Coastal Act. “Development”, as defined by the Coastal Act,

includes any action on land or in or under water which involves the construction, demolition, or alteration of a physical structure; the discharge of any waste or dredged material; changes in the density or intensity of land or water use, or access to water; and resource extraction, including vegetation removal (CA Pub Res Code § 30106). Accordingly, the Commission might review the environmental impacts of a wide range of activities, from building a bridge or remodeling a house to restoring a wetland or hosting a surf tournament on a public beach. In particular, the natural resource policies of the Coastal Act protect "environmentally sensitive areas"—usually referred to as "ESHA", an acronym for "environmentally sensitive habitat area"—defined as "any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments" (California Coastal Act § 30107.5). With regard to wetlands, the Coastal Act allows for the "diking, filling, or dredging of open coastal waters, wetlands, estuaries, and lakes" only under rare circumstances where there is "no feasible less environmentally damaging alternative, and where feasible mitigation measures have been provided to minimize adverse environmental effects" (CA Pub Res Code § 30233).

Prior to the Commission's consideration of a proposed project, staff review the application for compliance with the policies of the Coastal Act, then develop a staff recommendation with legal and technical findings. The recommendation often includes special conditions—such as avoidance and mitigation measures, best management practices, or compensatory mitigation—required to bring an application into consistency with the Coastal Act. This staff report informs the Commission's decision to approve or deny the project. The Commission can also alter staff recommendations prior to approval, sometimes so dramatically that the staff must produce a new report with revised findings. If the Commission approves the project in whole or in part, then the agency issues the applicant a coastal development permit (CDP) which finalizes the language of the approved staff report.

If a proposed project will destroy, displace, or otherwise disturb sensitive natural resources—i.e., environmentally sensitive habitat areas (ESHA), wetlands, or marine resources—and if this habitat disturbance is determined to be an unavoidable

“allowable use” which is crucial to an otherwise permissible project, then the permittee is generally required to offset or directly remediate those impacts via some form of compensatory mitigation. Broadly speaking, mitigation may be conceptualized as a sequence of actions involving first the avoidance of impacts where possible; then the minimization of unavoidable impacts; and finally, compensation to mitigate any remaining unavoidable impacts which cannot be further minimized (CCC 2014). Compensatory mitigation, which is the subject of this research, is distinguished from avoidance and mitigation measures (AMMs) and best management practices (BMPs) which may “mitigate” the impacts of a project but do not “compensate” for unavoidable impacts. The goal of compensatory wetland mitigation is to restore, create, enhance, or in some cases preserve wetland habitat to replace or improve habitat unavoidably impacted by development. In practice and through a record of established precedent, there is a strong preference for mitigation to occur on the same site where the impacts occurred, or in the same watershed. The intent is for the mitigated habitat to achieve equal or superior ecological function to the habitat which was disturbed by development.

Compensatory mitigation required by the Coastal Commission may take the form of habitat creation, substantial restoration, enhancement, or land/resource preservation. The Society for Ecological Restoration defines habitat restoration as “the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed” (SER 2002), while the National Research Council has defined it as the "return of an ecosystem to a close approximation of its condition prior to disturbance" (NRC 1992). In Coastal Commission mitigation projects, restoration can also be understood to restore a wetland ecosystem to a prior condition that was not necessarily caused by the development at issue—for instance, when a significant invasive ecosystem engineer (e.g. *Arundo donax* or *Tamarisk spp.)* is removed from a wetland habitat. Habitat creation is the "construction of a wetland in an area that was not a wetland in the recent past (within the last 100-200 years)” while enhancement is “the modification of specific structural features of an existing wetland to increase one or more functions based on management objectives” (Gwin, et al. 1999). Enhancement often entails the removal of invasive plant species, establishment of native species in their place, and subsequent maintenance thereof. Preservation is the setting aside of

habitat area via a conservation easement, land trust, open space restriction, or similar to ensure that a given location is closed off to development in perpetuity. The general order of preference for mitigation is restoration of the impacted habitat, then creation of new habitat, substantial restoration of an off-site habitat, enhancement of existing habitat, and finally preservation of existing habitat.

Depending on the habitat type, the nature of the impact, and the particular circumstances of a project, the Commission uses different “mitigation ratios” to determine how much habitat area is required to sufficiently mitigate the impact. The Commission typically requires a minimum ratio of 4:1 (mitigation acreage : lost acreage) for impacts to wetland habitat. In a November 2018 memorandum to North Coast District Supervisor Melissa Kraemer, staff ecologist John Dixon wrote a thorough explanation of the rationale for using a 4:1 minimum ratio for wetland impacts. Higher ratios—i.e., greater than 1:1—are used for sensitive, hard-to-restore habitats like wetlands, the guiding principle being that restoring ecosystem function over a larger area can compensate for the lengthy timeline involved in returning a degraded area to high-functioning habitat, thereby increasing the chance that the mitigation will be successful in the long term (Dixon 2018). The higher ratio is also meant to compensate for the temporal loss of habitat for resident species while the disturbed area recovers. Finally, the ratios are set as high as they are to compensate for the fact that restoration oversight is often lacking, making full ecosystem recovery difficult to achieve. As such, the additional area restored through the mitigation process is intended to compensate for the potential failure of mitigation efforts.

Within a given habitat category, mitigation ratios vary by mitigation type—i.e., whether a project constitutes habitat creation, substantial restoration, enhancement, or preservation. The Coastal Commission typically requires a 4:1 ratio for wetland creation or substantial restoration. Impacts to riparian habitat and other forms of environmentally sensitive habitat (ESHA) are typically mitigated a 3:1 ratio. Certain other types of ESHA have unique mitigation standards, and certain regional management plans within the Coastal Zone require unique ratios—for instance, 1.2:1 for impacts to eelgrass under the National Marine Fisheries Service’s California Eelgrass Mitigation Policy (NOAA 2014) and 10:1 mitigation for impacts to native oak trees under the Los Angeles County

Oak Protection Ordinance and Coastal Implementation Plan (Dagit et al. 2019). Approximately 25 percent of Local Coastal Programs establish unique mitigation ratio policies for various coastal resources.

The same mitigation ratios are used for each habitat category (wetland, riparian, ESHA, etc.) regardless of the pre-impact condition of the impacted habitat. Thus, impacts to a pristine coastal wetland would be mitigated at the same ratio as a highly degraded or low-quality wetland (e.g. a small, isolated wetland located next to a highway, or a wetland which has developed in a concrete storm drain). The policy rests on an established case law precedent which holds that compensatory mitigation requirements should conform to agency policies even in cases where the impacted wetland is already degraded (*Kirkorowicz v. California Coastal Commission* 2000).

Within the broad categories of restoration, creation, and enhancement, mitigation requirements differ based on the longevity of the impact, the location of the mitigation, and whether the mitigation is “in-kind” or “out-of-kind”. At the Coastal Commission, habitat impacts are typically described as “temporary” or “permanent”. Though the body of commissioners has not approved an official definition of these terms, a wetland impact is generally considered “permanent” if the impact to the habitat will last longer than one year, including where habitat is developed or frequently disturbed to maintain the development. All other impacts in which the habitat recovers within a year are considered “temporary” (Koteen, L., April 7, 2020). Additional compensatory mitigation is typically only required for temporary impacts if evidence of an impact at the site is apparent 90 days after the end of construction activities. If an impact originally planned as temporary ends up affecting the site for longer than a year, then it is considered permanent and requires compensatory mitigation.

Impacts may be mitigated on-site (i.e., within or adjacent to the impacted habitat) or off-site (i.e., at another location), with preference typically given to mitigation conducted on-site or in the same watershed. The reason for this preference is that on-site or same-watershed mitigation helps minimize localized habitat loss and preserve population-level diversity among vegetation communities, which in turn helps preserve ecosystem resilience. Temporary impacts are typically mitigated on-site via restoration of the impacted habitat—by definition, they recover in-place with or without assistance—

while permanent impacts may be mitigated either on- or off-site. Impacts may also be mitigated in-kind (i.e., when the habitat created, restored, or enhanced by the mitigation is of the same type as the habitat impacted) or out-of-kind (i.e., when the mitigation habitat type does not match the impacted habitat type). In-kind mitigation is strongly preferred where possible so as to prevent the loss of any one habitat type. This preference is also partially due to the complex calculations and large amount of assumptions required to determine how the loss of one habitat area translates to the restoration of another (CCC 1995). However, in some cases out-of-kind mitigation is substituted due to the availability or contiguity of a particular parcel, or due to the difficulty of replacing a particular resource type. In one recent example of out-of-kind mitigation, a permit issued in 2018 allowed for the landscape-level removal of invasive *Spartina* cordgrass as habitat enhancement to compensate for impacts to wetland habitat along a highway median (Dixon 2018).

In some cases, a monetary fine or "in-lieu fee"—often contributed to a regional mitigation bank or conservation fund, or purchased from a sponsor—is used to compensate for unavoidable impacts in lieu of a permittee-responsible mitigation project. Some permittees also consolidate mitigation into regional "mitigation banks" where the impacted acreage for various unrelated projects is mitigated at a single site to reduce administrative overhead, take advantage of ecological and financial economies of scale, provide a more resilient end result than small or isolated projects might, and maximize the likelihood of meeting performance criteria. Mitigation banks can also enable large-scale mitigation projects that support numerous species and provide multiple ecosystem services in lieu of more modest piecemeal efforts. This allows for the related practice of advance mitigation, which is when a permittee performs more mitigation than is immediately necessary and applies the extra acreage later to offset impacts to other projects (Hough and Harrington 2019), or when the mitigation project precedes habitat impacts and can be verified as successful, thereby reducing acreage requirements. Mitigation banks are sometimes used by transportation agencies (e.g. Caltrans), energy companies (e.g. PG&E, Southern California Edison), and other entities with a variety of ongoing infrastructure projects. Depending on the permittee, the project, and the region, in-lieu fees or mitigation banks may be more or less preferable

than the other types of compensatory mitigation. A 2008 “Mitigation Rule” published by the U.S. Army Corps of Engineers and the Environmental Protection Agency states that mitigation banks and in-lieu fees tend to involve larger sites and more rigorous technical analysis, and as such are typically considered to be environmentally preferable to project-specific “permittee-responsible mitigation” (USACE and EPA, 2008). On the other hand, given that it is conventionally considered best practice to mitigate impacts in-kind and on-site (or in the same watershed), permittee-responsible mitigation may be preferable to a mitigation bank or in-lieu fee if it is possible to mitigate the impacts locally at sufficient scale (California Coastal Commission 1995).

Once the basic details of the mitigation—e.g., the type and the ratio, and whether it is to be conducted on-site or off-site—are determined, the permittee must submit a mitigation and monitoring plan describing a detailed strategy to compensate for the impacts. Once the Commission approves the permit and the associated mitigation and monitoring plan, the permittee is responsible for fulfilling and tracking all mitigation requirements within a reasonable period following the permitted impacts. Permit conditions requiring compensatory mitigation will often specify that a final mitigation and monitoring plan be submitted either prior to the approval of the CDP or within 30-60 days of the commencement of construction. The permittee usually has two years to implement the proposed development following the approval of the permit, although they may apply for extensions in one-year intervals.

Once a mitigation project is implemented, permittees must submit annual monitoring reports for a set period—usually five years—or until the mitigation meets the performance standards outlined in the final mitigation plan. Performance standards for compensatory wetland mitigation often include the percent survivorship of container plants, percent native versus non-native plant cover, and overall percent vegetation cover, as determined by a quantitative field survey. Historically, performance criteria have focused on vegetation metrics but have ignored other key measures of wetland ecosystem function such as hydrology, soils, topography, and wildlife (Matthews and Endress 2008, Sueltenfuss and Cooper 2019).

It is important to note that while these vegetation-based performance standards do indicate whether a project has been successful in an administrative sense, they

remain limited measures of ecological function. For instance, if a marsh restoration site is deemed to have met its five-year performance criteria because 60% of the planted vegetation survives to the fifth year of monitoring and native plant cover is estimated at 50%, the underlying assumption is that the ecosystem is functioning roughly as it should, or is on a trajectory to full ecosystem function—but in reality, this may not be true. Furthermore, the full restoration or creation of various important ecological functions often takes much longer than the mandated monitoring period, even if all the stages of a mitigation project are completed on time.

Another factor which bears mention is that wetland mitigation projects vary widely by size. Even very small impacts to a fraction of an acre—even less than 100 square feet—are subject to the wetland protection policies of the Coastal Act. Thus, a thorough study of compensatory wetland mitigation projects must include a range of impacts from very small (i.e. less than a tenth of an acre) to very large (i.e. more than ten acres) as

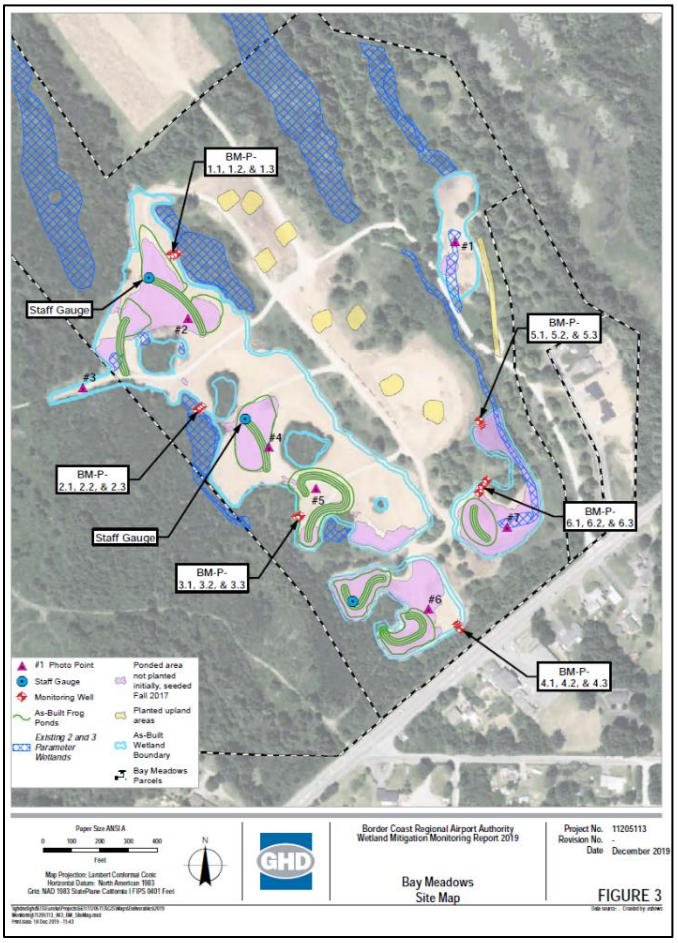

Figure 3: Large Wetland Creation Site

Source: CDP 1-14-0820; GHD Group

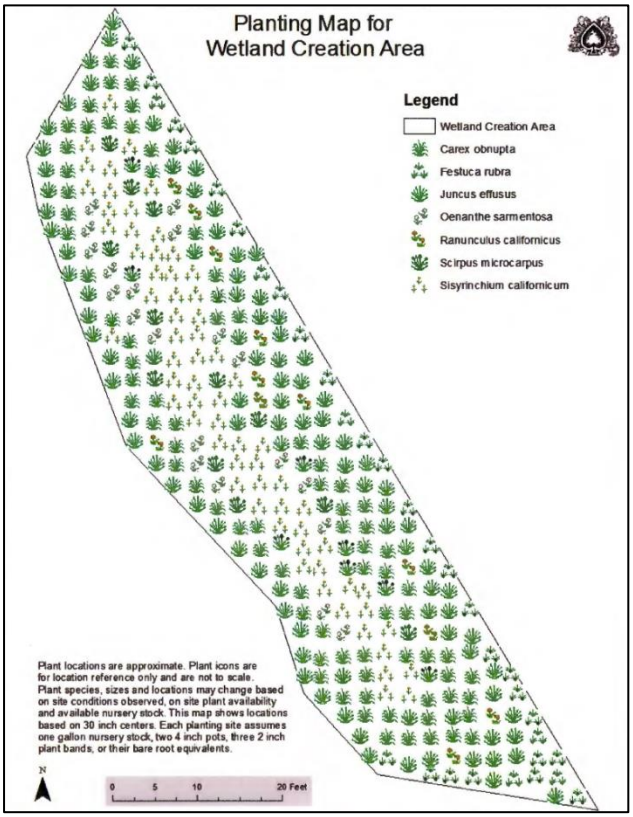

Figure 4: Small Wetland Creation Site

Source: CDP 1-16-0122; Spade Natural Resources Consulting

well as various intermediate sizes. Figure 3 is an example of a relatively large, complex wetland creation site (13.9 acres), while Figure 4 depicts a very small wetland creation site (0.14 acres) with a much simpler planting plan.

Larger mitigation projects—for instance, the San Onofre Nuclear Generating Station (SONGS) wetland mitigation site in San Diego County—are more complex. As such, they typically undergo a more comprehensive monitoring process than smaller projects, including more attention from Commission staff, more funding, and a greater number and diversity of performance standards (Koteen, L., April 4, 2020).

The U.S. and California each have “no net loss” (NNL) policies which aim to offset wetland loss so that the total acreage increases or at least stays constant. The federal NNL policy, adopted in 1989, seeks to “establish a national wetlands protection policy to achieve no overall net loss of the nation's remaining wetland base, as defined by acreage and function, and to restore and create wetlands, where feasible, to increase the quality and quantity of the nation's wetland resource base” (Gittman et al. 2019). The California Wetlands Conservation Policy, adopted in 1993, sets a goal of no net wetland loss and also aims to “achieve a long-term net gain in the quantity, quality, and permanence of wetlands acreage and values in California in a manner that fosters creativity, stewardship, and respect for private property” (California Natural Resources Agency 1993). In accordance with these policies, the Coastal Commission defines full, successful wetland mitigation as that which results in no net loss of wetland acreage or function (California Coastal Commission 2016). Of the acreage that is restored or created as compensatory mitigation, the portion that achieves full ecological function is sometimes called the “functional mitigation acreage”.

Although compensatory wetland mitigation is a well-established practice at the California Coastal Commission, there is a lack of both agency documentation and peer-reviewed literature (see Section 2, Literature Review) evaluating whether the agency’s mitigation program is effectively compensating for impacts to wetland habitat. This gap presents ample opportunities to investigate the Commission’s compensatory mitigation program, evaluate whether it has been successful, and make recommendations for best management practices.

2. Literature Review

The core of this research is an archival analysis of all coastal development permits, mitigation plans, monitoring reports, agency correspondence, and technical memoranda associated with the compensatory wetland mitigation projects permitted by the California Coastal Commission between 2012 and 2018. This primary research is contextualized by a literature review of case studies and comparative analyses that have evaluated other compensatory mitigation programs in California, other states, and other nations. Chapter 3 of the Coastal Act, entitled Coastal Resources Planning and Management Policies, forms the statutory basis of the Commission's compensatory wetland mitigation practice, but the guidelines governing practical details such as mitigation ratio, timeline, definitions, and performance standard(s) have been set forth and modified over time in technical memoranda, permit language, and mitigation plans. Thus, this study also reviews relevant agency materials.

This literature review uncovered little to no peer-reviewed research regarding the success of the Coastal Commission's compensatory mitigation practice, although there is evidence that comparable policies in other parts of California and throughout the U.S. have largely failed to offset the impacts of development. Wetland mitigation permitted under the federal Clean Water Act section 404 has been particularly well studied, though other researchers have focused on state programs and on mitigation programs outside the United States. The Commission's procedural guidelines for evaluating wetland mitigation projects were published in 1995 and still exist in their original form on the agency's website (CCC 1995). The agency also draws guidance from the California Code of Regulations, Title 14 (Natural Resources), Division 5.5 (California Coastal Commission), a set of rules with the force of law which outlines topics such as meeting procedures, staff roles and duties, the contents of coastal development permits, and the scope of the agency's enforcement responsibilities (14 CCR § 13001-13666.4).

Although compensatory mitigation policies are widespread in the U.S., the existing literature indicates that they have broadly failed to achieve "no net loss" of wetland acreage, not to mention ecological function (Turner et al. 2001, Ambrose and Sudol 2002, Zedler 2004, Ambrose et al. 2007). Even where compensatory mitigation

projects did meet their performance standards, independent field surveys have found that compliance often does not equate to habitat quality (Ambrose and Sudol 2002). Other studies have found significant gaps in the monitoring and tracking of mitigation projects (Owley 2015, Weissgerber et al. 2019). To rectify these issues, researchers have suggested using more comprehensive performance criteria, setting realistic goals based on reference sites, and describing the offsetting measures in greater detail (Turner et al. 2001, Matthews and Endress 2008, Weissgerber et al. 2019).

In 2001, the National Research Council—the working arm of the U.S. National Academies—published a sweeping analysis of peer-reviewed and "gray" literature on federal wetland mitigation which found that only about 20 percent of wetland impacts were actually offset by the Clean Water Act section 404 permitting program. This means that nationwide, the program allowed an 80 percent loss of wetlands. Furthermore, only 14 percent of the projects reviewed were deemed to be functionally equivalent to reference sites (Zedler 2004). A follow-up report by three members of the National Research Council's Committee on Mitigating Wetland Losses (Turner et al. 2001) found that this broad failure to achieve program goals was associated with administrative issues such as the lack of monitoring, the lack of deadlines, and the lack of sufficiently specific performance criteria. They suggested that program outcomes might be improved by including more ecologically-focused success criteria and locating mitigation sites in the same watershed as the impact. With regard to mitigation monitoring, the researchers pointed out that permittees' self-interest in reporting compliance with mitigation goals might influence the accuracy of site evaluations, casting further doubt on whether reported compliance with administrative requirements actually corresponded to on-the-ground ecological function.

Other studies have focused on local and state-level implementation. Breaux and Serefiddin (1999) followed up on 116 compensatory wetland and riparian mitigation projects filed with the San Francisco office of the U.S Army Corps of Engineers between 1988 and 1995. They found that 482 total acres were created and restored (364 ac created, 118 ac restored) to offset 548 acres of wetland loss, although they noted that an additional 136 acres of planted upland buffers could be technically counted as mitigation acreage to result in a net gain in wetland area. The study also found 598

acres of enhanced wetlands and 27 acres of preserved wetlands associated with the projects. However, the authors noted that enhancement and preservation are often not included in the determination of net gain/loss ratios because they do not represent a "direct gain in wetland area".

Sudol and Ambrose (2002) assessed all 55 compensatory mitigation projects permitted under the Clean Water Act and the Rivers and Harbors Act from 1979-1993 in Orange County, CA and found that only 55 percent met the permit conditions and performance standards. When the researchers performed their own qualitative field assessment of habitat quality for the projects in question, they determined that only 16 percent could be considered successful. In 2007, Ambrose et al. reviewed case files and performed field evaluations for 143 compensatory wetland mitigation projects permitted throughout California by the Regional Water Quality Control Boards under the Clean Water Act. They found that although permit conditions were satisfied up to 75 percent of the time, the associated mitigation rarely resulted in high-functioning wetlands. These findings point to a significant, often invisible gap between the satisfaction of performance criteria and the practical creation or restoration of functional mitigation acreage.

Breaux et al. (2005) published a review of permit compliance and habitat function for 20 compensatory wetland mitigation projects in the San Francisco Bay Area. Unlike other studies which have found gaps in both compliance and function, Breaux et al. concluded that the majority of projects permitted in the year 2000 or earlier had met the permit conditions and were displaying adequate ecological function. They did, however, observe that restoration sites which were larger and hydrologically contiguous with existing wetlands tended to achieve greater permit compliance and offer more habitat value than smaller, more isolated restoration sites. The researchers, who were testing a new rapid field assessment method, emphasized that a truly comprehensive evaluation of project success would require a mixture of professional judgment, regulatory experience, and contextualizing information.

BenDor and Brozović (2007) published an analysis of 1058 wetland mitigation transactions permitted under local and federal regulations between 1993 and 2004 in the Chicago area. They found that 2634.2 wetland acres were restored, created, or

preserved to mitigate for at least 1544.2 impacted acres, and that 59.4% of these impacts were mitigated off-site—particularly small impacts. Furthermore, the authors showed that the prohibition of cross-county mitigation in local wetland mitigation programs led to greater rates of cross-watershed mitigation, suggesting that locally-administered programs tended to choose sites based on administrative boundaries rather than optimizing for hydrologic function. The California Coastal Commission, as a state agency, may be better equipped to prioritize hydrology. Indeed, the Commission's practice, in keeping with EPA guidelines, is to conduct compensatory mitigation within the same watershed as the impacts when possible, with on-site mitigation even more preferable (EPA 2015).

The above-cited studies were primarily concerned with evaluating the success of individual compensatory wetland mitigation programs in order to diagnose and thereby overcome obstacles to compliance. Such studies have generally concluded that the condition compliance of a compensatory mitigation project is largely dependent on the relevance and achievability of the performance criteria used to gauge project success. Some researchers have gone on to argue that using more inclusive performance standards—rather than just surveying vegetation metrics at a site—can more accurately measure ecological function and might even improve project success.

Matthews and Endress (2008) evaluated the performance criteria and compliance success of 76 artificial wetlands which were completed in 38 Illinois project areas between 1992 and 2002 and monitored annually for 1-5 years. The performance criteria were predominantly focused on the vegetation community as a proxy for wetland hydrology and overall ecosystem function. The researchers found that while the sites consistently met basic vegetation cover requirements, many sites failed to meet performance standards relating to plant survivorship or native species dominance. Indeed, they noted, some standards—e.g. percent vegetation cover, percent hydrophyte cover—were so loose as to be nearly meaningless, while others—e.g. no exotic or weedy dominant species, percent of planted herb species surviving—were too stringent for projects to achieve compliance within temporal and budgetary constraints. Sites with fewer performance standards were more likely to be deemed successful. Ultimately, the authors recommended expanding performance criteria beyond strictly vegetation—to

include, for instance, hydrology, soils, topography, and wildlife—and setting more realistic goals based on nearby reference sites.

Craft and Hopple (2011) argued that comparing wetland mitigation sites to "reference sites"—habitat areas within the same region used as a benchmark against which to gauge the mitigation site's ecological function—is an important tool for evaluating the success of compensatory mitigation permitted under Section 404 of the Clean Water Act. The researchers compared vegetation- and soil-based performance criteria for tidal saltmarsh mitigation project to a single reference site ("reference pair") and a group of spatially distributed reference sites ("reference population"). They found that vegetation-based criteria such as plant stem height and above-ground biomass were strong predictors of functional equivalence when compared to a single reference site, whereas soil-based criteria such as organic carbon and nitrogen levels were even stronger predictors of equivalence, but only when compared to a reference population.

Sueltenfuss and Cooper (2019) published a study analyzing how long it took for water levels in various restored wetlands across the United States to match reference sites. They found that vernal pools in California took nine years on average to match the hydrology of reference sites; fens and wet meadows in Colorado took six years; and forested wetlands in the southeastern U.S. took one year or less. The authors further observed that native plant cover was higher—and in fens and wet meadows, exotic species cover was lower—in restoration sites where the water level was more similar to reference sites. These results underscored the importance of hydrology to wetland function and suggested that hydrologic performance standards could improve the success of vegetation restoration in some types of wetland.

The U.S. Army Corps of Engineers, which has federal jurisdiction over wetlands and other Waters of the U.S., uses a three-parameter approach to delineate wetlands. In order to meet the definition of a wetland, a sample point must exhibit hydrophytic vegetation, hydric soil, and wetland hydrology. Hydrophytic vegetation describes plants that have developed adaptations to survive in saturated conditions; wetland hydrology involves inundation for at least 14 days during the growing season; and hydric soil displays evidence of ongoing saturation and oxygen depletion (Environmental Laboratory 1987). The presence of hydrophytic vegetation alone is typically not

sufficient justification that a site is a wetland, although the presence of hydrological and soil indicators may be used in the absence of discernable hydrophytes in situations where the vegetation is significantly disturbed or where normal conditions are not present (USACE 2008). The California Coastal Commission is atypical in that it allows a more permissible single-parameter approach for wetland determinations—i.e., the presence of any one of the three parameters at a site is considered to be sufficient justification that a wetland exists.

It stands to reason that in a thorough evaluation of ecological function in a restored or created wetland, mitigation success criteria would employ techniques from the multiparameter approach typically used for wetland delineation. However, in practice, the short time period of mitigation monitoring often precludes this approach. While hydrophytic vegetation can become established within a single growing season, hydric soils take years to develop, and are dependent upon the sustained presence of wetland hydrology and hydrophytic vegetation. Furthermore, conditions surveyed immediately after the establishment of a mitigation site may not be functionally equivalent to the average conditions for a fully functioning ecosystem, which also reflect the cumulative effects of time. (Koteen, L., May 4, 2020)

There are several reasons why vegetation indicators are commonly used to assess ecological function in compensatory wetland mitigation monitoring. First, wetland vegetation forms the base of the ecosystem and provides a directly observable gauge of whether primary production is occurring. Second, wetland vegetation provides habitat for a wide variety of other taxonomic groups from bacteria, macroinvertebrates, and algae to amphibians, fish, and mammals, making the presence of a robust vegetation community a useful indicator for whether the site harbors or is capable of harboring wetland-associated wildlife. Third, wetland vegetation influences the development of hydrological and sediment-based indicators: plants can act as a “nutrient pump” to improve water quality, and also act to stabilize sediments and shape water currents (U.S. EPA 2002). Fourth, given that wetland hydrology and hydric soils take time to develop, and that it may take years for full ecosystem function to emerge in an artificial wetland, sampling key vegetation indicators can provide an early assessment of whether a site is on track to eventually meet hydrology, soil, chemical, and wildlife

parameters. Finally, vegetation is a convenient indicator to survey: plant cover and community composition are directly observable without invasive sampling techniques, can be communicated easily through pictures, and can potentially even be surveyed using remote sensing techniques. Sampling sediment composition and water quality may require more specialized equipment, and assessing indicators such as soil saturation and redoximorphic activity typically requires digging holes for soil profiles. Thus, it is not entirely surprising that vegetation-based mitigation success criteria are more common than other types, though this does not preclude the potential utility of employing a broader range of indicators in monitoring.

In a 2001 handbook on measuring and monitoring plant populations, Elzinga et al. proposed that complete and clearly written performance criteria possess six key elements: 1) a species or habitat indicator identifying what will be monitored; 2) a clear description of the site or planting location; 3) the attribute or metric of the species or habitat indicator which is being surveyed; 4) the action being taken to meet the mitigation objective; 5) the measurable quantity, criterion, or degree of change which the selected attribute must meet; and 6) the time frame within which the mitigation is expected to meet the success criteria.

The Washington State Department of Transportation (2017) published a guide to writing compensatory wetland mitigation performance standards which noted that it can be challenging to establish meaningful criteria based on wildlife because, unlike plants, animal range is typically not limited to the boundaries of a particular site. As such, the ecological function of a wildlife community is more dependent upon uncontrollable factors beyond the scope of the mitigation plan. However, the paper noted that counts of woody brush stands, snags, rock piles, and other landscape features known to shelter wildlife can serve as a meaningful proxy for or supplement to direct wildlife observations (WSDOT 2017). The authors also specified that because it is unrealistic to develop a uniform set of performance criteria which work equally well for all sites, standards should be site-specific wherever possible.

Other researchers have emphasized failures in the monitoring and tracking of compensatory mitigation projects by focusing on procedural clarity and monitoring compliance rather than the technical details of ecological function. Jessica Owley (2015)

published case studies for the compensatory mitigation associated with four California habitat conservation plans in which she described a troubling lack of follow-through on the part of the U.S. Fish and Wildlife Service. Many mitigation and monitoring records were simply not available at the ostensibly responsible field offices despite Owley's persistent efforts to communicate with agency staff. These issues are not endemic to California or even to the U.S. Weissgerber et al. (2019) reviewed administrative and procedural documents for 24 French compensatory mitigation projects and found that the impacts were described in far greater detail than the offsetting measures, making it difficult to assess whether the net gains were sufficient to offset the net losses.

It is also important to note that although the expressed goal of compensatory mitigation is "functional equivalency" to the disturbed habitat area or to an ecologically healthy reference site, what this equivalency looks like—and the amount of time needed to establish it—depends on factors including the wetland type, the level of disturbance, and the proximity to other functioning habitat area. Zedler and Callaway (1999) posited that achieving functional equivalence within 5-10 years is far from a given, and is likely to occur only in "low-stress" systems. They suggested that more complex wetland types, such as species-rich ecosystems or those which can only exist within a narrow range of water quality conditions, could require a much longer timeline on the order of 20-100 years to achieve the full replacement of lost ecosystem function. In some cases, it may not be possible to ever achieve full functional equivalence. This is a major caveat for compensatory wetland mitigation programs—one which makes it even more important to study whether they are working, and which further underscores the importance of avoiding wetland impacts altogether when possible.

In summation, a review of relevant literature suggests that although compensatory wetland mitigation programs have slowed the rate of wetland loss in California and elsewhere, they have largely failed to offset impacts with a sufficient amount of functional mitigation acreage. Some studies have observed that performance standards are often biased toward measuring vegetation communities and do not account for other relevant factors such as hydrological conditions, soils, wildlife, and reference sites. Due in part to this reliance on vegetation-based performance criteria, condition compliance is only a proxy for habitat quality. Independent field surveys have

identified significant gaps between reported and actual functional mitigation acreage. A common recommendation is that compensatory mitigation programs should implement a more diverse range of performance criteria, particularly those involving hydrology and comparison to reference sites.

3. Data and Methodology

The first phase of this study was to review all permits issued by the California Coastal Commission between 2012-2018 and catalog details about those that required compensatory mitigation. The next phase was to obtain plans and monitoring reports for the subset of compensatory mitigation permits which involved impacts to wetland or riparian habitat. The next step was to evaluate, based on the available data, whether the compensatory wetland mitigation program was successful. This study addressed the question of success via three sub-questions (Table 1), using statistics, charts, tables, and discussion to evaluate the relationship between impacted acreage and required mitigation acreage; explain patterns in permit success rates between districts, habitat types, and mitigation types; and describe gaps in the availability of monitoring data.

Table 1: Research Questions and Associated Methods

Research Question	Methods
Was there a net gain or a net loss of wetland acreage over the study period?	• Reviewed permits, plans, and monitoring reports to identify impact vs. mitigation acreage and ratios used for each project • Statistical analysis of net wetland acreage and impacts by region and habitat type • Statistical analysis of mitigation ratios used for temporary vs. permanent impacts • Statistical analysis of impact size
Have some districts, habitat types, or mitigation strategies been more or less successful at mitigating losses of ecological function?	• Reviewed plans and monitoring reports for 25 projects to populate database with 331 unique performance criteria used across all years of monitoring data available • Statistical analysis of performance criteria compliance by metric type, mitigation type, habitat type, and region
How thoroughly is the Commission monitoring permit compliance?	• Logged success in obtaining records for each wetland mitigation project • Case study analysis of reasons why many records were not available

Source: Research questions and methodology developed by author

3.1 Cataloging Compensatory Mitigation

This research reviews all available documents—including coastal development permits, mitigation and monitoring plans, correspondence, technical appendices, and monitoring reports—for a subset of compensatory wetland mitigation projects permitted in the California Coastal Zone between 2012-2018 in order to evaluate project success as a function of compliance with performance criteria. The initial scope of this research included all six districts of the Coastal Zone, although no usable documents were found for the Central Coast region. In addition to straightforward compensatory mitigation, this research investigates Enforcement mitigation required for Coastal Act violations as well as Energy and Ocean Resources projects wherein mitigation was required for marine impacts or large-scale energy infrastructure. The unit of analysis is a single permit, though permits are also categorized by district (North Coast, San Diego Coast, etc.), year (which reflects the particular makeup of the Commission and its staff at a given point in time), habitat type (e.g. tidal wetland, freshwater wetland), and mitigation type (i.e., habitat creation, substantial restoration, enhancement, and/or preservation). The initial scope of data collection included all habitat types, but this analysis focuses on freshwater wetlands, tidal wetlands, and riparian areas.

Throughout 2019, I volunteered part-time as a graduate student researcher in the San Francisco headquarters of the California Coastal Commission, where I worked closely with staff ecologists to define the scope of my research. No one had previously catalogued and analyzed the Commission's compensatory mitigation practice from a programmatic perspective. Thus, the first step was to systematically populate a spreadsheet with information about all compensatory mitigation required for projects permitted by the Coastal Commission between 2012 and 2018. This process entailed reviewing hundreds of historical staff reports—i.e., every coastal development permit issued over that period—to establish which projects had required compensatory mitigation as a permit condition. The staff reports for every Coastal Commission hearing from November 1995 to present are hosted online for public viewing at www.coastal.ca.gov/meetings/archive/, so it was possible to access the files for this initial sweep without making any record requests.

An early phase of this research entailed experimenting with writing a Python script which scraped the HTML on the Coastal Commission website for staff report links, downloaded staff reports one by one as PDF files, and then parsed those PDF files for keywords which indicated a compensatory mitigation requirement. However, due to the variations in language, formatting, and level of detail included in these staff reports, it was ultimately most effective to review all staff reports manually. In most cases, a quick review—i.e., skimming the most relevant sections and, where possible, performing a battery of keyword searches—was sufficient to determine whether a particular CDP imposed or implemented a compensatory mitigation requirement. See Appendix B for a description of the standard structure of a Coastal Commission CDP staff report as well as the methodology I used to review said reports.

The initial review revealed 338 compensatory mitigation projects which were permitted between 2012 and 2018. Findings were recorded in a database containing basic information about each permit (e.g. Coastal Zone district, staff analyst name, address, project description) as well as more detailed information about the mitigation plan (e.g. acreage impacted, mitigation ratios used, on-site vs. off-site restoration, in-kind vs. out-of-kind mitigation, performance standards). Of these 338 projects, 44 involved mitigation for tidal wetland impacts, 58 involved freshwater wetland impacts, and 52 involved riparian impacts—including 20 projects which mitigated both freshwater wetland and riparian impacts. This research evaluates all wetland and riparian compensatory mitigation projects required during the study period—126 projects in all.

This main compensatory mitigation database spans 338 rows and 50 columns. The sheet created to document the subset of wetland and riparian projects contains 126 rows and 59 columns; several columns track the availability of monitoring reports and the progress of mitigation, where discernable. This data, although still incomplete in places, represents the first effort to systematically document compensatory mitigation requirements permitted by the California Coastal Commission.

3.2 Locating Mitigation and Monitoring Reports

In order to evaluate the success of the 126 compensatory wetland mitigation projects permitted between 2012 and 2018, it was first necessary to locate and review

the final mitigation plans and annual monitoring reports associated with each project. This phase of the research entailed extensive correspondence with Commission staff over the course of several months in late 2019 and early 2020. The process of attempting to locate reports revealed gaps in the availability of monitoring documents as well as cases in which mitigation requirements were not being enforced.

First, for context: a mitigation plan describes in detail the habitat impact which is being mitigated (e.g., 0.15 acres of tidal wetland are being permanently destroyed by an airport runway expansion project), the goals of the mitigation project (e.g., to implement the restoration of 0.6 acres of degraded tidal marsh at a different site within five years of impact), the methods which will be used to mitigate said impacts (including cost, timeline, species to be planted, and other details), and the specific performance criteria by which the mitigation will be evaluated (e.g., annual vegetation surveys to determine that the site is meeting certain benchmarks for percent native plant cover and percent survival of planted vegetation). The annual monitoring reports, which document compliance with the goals laid out in the mitigation plan, usually contain a brief reiteration of project goals, a description of monitoring methods and performance criteria, a summary of any data collected, photographs of the site, conclusions about whether the project is meeting its goals, and, if necessary, management recommendations to help bring the mitigation into compliance.

A permittee generally submits the final mitigation plan after the approval of the permit, but prior to the beginning of mitigation, except in rare cases where the plan is finalized prior to permit issuance. Monitoring reports, often prepared by a consulting firm, typically must be submitted to the Commission on an annual basis for five years following the implementation of mitigation, or until the performance criteria have been met for a minimum amount of time.

It is important to note that coastal development permit staff reports rarely contain the full scope of the mitigation requirements for a particular project. Often, the exact acreage of habitat impacts is not known at the time of permit approval, and neither is the location of any off-site mitigation. The staff report sometimes specifies certain performance criteria which must be included in the final mitigation plan, but more often the permit only goes as far as requiring the preparation of such a plan. Thus, reviewing

final mitigation plans and monitoring reports was important not only for evaluating the success of mitigation requirements, but for understanding the scope of those requirements in the first place.

Again, the permittee is responsible for submitting monitoring reports on an annual basis for five years or until the performance criteria are met. Usually, the permittee or their environmental consultant sends the completed monitoring reports to the Commission staff analyst who is responsible for permitting the project. However, there is no formal procedure for cataloging and retaining these reports once they have been submitted. In theory, the analyst adds each successive monitoring report to the file for that permit, which ensures that all relevant documents are in the same place and easily retrievable. Until at least 2013 or 2014, permit documents were kept primarily in physical files stored on-site at the responsible regional office or, for older projects, at the Commission's archives in Sacramento. Documentation for more recent permits is maintained in digital form on the Commission's intranet, to which I had access as an intern. However, in practice, many monitoring reports were never added to the project file or otherwise aggregated, meaning that it was necessary to contact agency staff directly to locate the documents.

A column in the project database identified the staff analyst who handled each permit. Although many of these staff members were still at the Commission, a number of them were not—especially for projects permitted in 2015 and earlier. The staff members responsible for preparing permits are usually "coastal program analysts", a job classification with relatively high turnover. Thus, for the sake of efficiency and because it was not always clear whether the analyst named in the staff report was still the appropriate contact, I emailed the district managers for each of the six regional Coastal Commission offices explaining the scope of the research and asking for assistance. I provided my data for the subset of compensatory wetland mitigation permits prepared in each district office, and each of the managers connected me with the appropriate current contact for each project in their district. The Ventura office assigned one staff member the role of collecting and then providing the mitigation and monitoring reports for all the projects on that region's list; other offices simply listed the name of the appropriate contact for each project and allowed me to do to the outreach.

This outreach phase identified 57 staff members who were recommended contacts for one or more of the 126 permits where compensatory wetland mitigation was required. Having ascertained the appropriate contact for each project, I proceeded to correspond with staff throughout California by email, asking for any final mitigation plans and monitoring reports that were available for each mitigation requirement. Staff members were largely willing to help, although requested documents were not always forthcoming, for reasons described in further detail in the Analysis and Findings section of this report. This correspondence phase roughly spanned the period from September 2019 through March 2020. In some cases, it was necessary to communicate with multiple staff members about a given report, and it was frequently necessary to follow up multiple times with the same staff member in order to get an answer. For those permits where only physical copies of documents were available, the only option was to wait weeks to receive boxes from the Commission archives in Sacramento, then manually review each file to ascertain whether the mitigation plan and monitoring reports were contained therein. Many projects had to be omitted from the performance criteria success analysis due to plan or report unavailability, including difficulty of access. Ultimately, this data-gathering surfaced mitigation plans or monitoring reports for 32 permits out of 126—slightly more than a quarter—with statistically usable monitoring data available for 25 permits, approximately one-fifth of the total.

3.3 Analyzing Mitigation Success

After locating all available mitigation plans and monitoring reports, the next phase in the research was to populate a new “performance tracking” spreadsheet with each performance criterion for each year of each project as a unique record. The performance tracking spreadsheet includes columns for permit number, district, habitat type, acreage of impacts and associated mitigation, mitigation type, mitigation ratio, mitigation progress, and monitoring year. This data structure made it possible to analyze the success of in-progress mitigation on a per-year basis, and thereby to compare the monitoring reports available for the in-progress projects to the monitoring reports from comparable years of completed projects. It also made it possible to evaluate mitigation success on several scales—from the net performance of particular

regions, to the success reported for a single coastal development permit, to the yearly compliance with individual performance criteria—in order to take a comprehensive view of the Commission's compensatory mitigation practice.

Again, the primary research question is whether compensatory mitigation required by the California Coastal Commission over the past decade has been successful in restoring lost wetland acreage and ecological function. This broad, overarching question is addressed in the Analysis and Findings section through the investigation of several sub-questions, described below, accompanied by a series of summary tables and charts which describe trends in the data by district, habitat type, acreage, mitigation type, mitigation ratio, and success criteria.

The first sub-question is whether there was a net gain or a net loss of functional wetland acreage in the California Coastal Zone over the study period. A further sub-question is: in what proportion of mitigation projects did the "functional mitigation acreage" equal or exceed the acreage lost? To be clear, a net loss of wetland acreage would mean that the acreage of impacted wetlands was greater than the acreage of restored, created, or enhanced wetlands. Whether the acreage is "functional" is more difficult to discern. As described in the Literature Review section, there is evidence that in jurisdictions outside the Coastal Zone, the actual acreage of wetlands restored, created, and/or enhanced (as measured using independent, field surveys) is often substantially lower than the official mitigation acreage. Due to a limited timeline, budget, and scope, this study uses the data contained in monitoring reports as the primary source for gauging the success of a project (rather than employing such techniques as remote sensing or boots-on-the-ground field surveys to validate the monitoring report data). Thus, this paper assumes that the monitoring report data represents the on-the-ground conditions with reasonable accuracy, and that if the Commission has signed off on a mitigation requirement as being fulfilled, that the mitigation acreage is sufficiently "functional" for the purposes of this study. That said, in an effort to approximate the robustness of the performance criteria compliance data, this paper also analyzes the spread of the number and diversity of performance criteria required per impact.

This data addresses the question of "net loss" by carefully tallying four variables for each project: the impacted acreage, the required mitigation ratio, the required

mitigation acreage as permitted, and the actual as-built mitigation acreage (where actual acreage differed from permitted acreage). This led to statistical analysis of net wetland acreage, noncompliant acreage, and impacts by region and habitat type. A summary table describes the relationship between impacted acreage, mitigation acreage, and “noncompliant” acreage. This research sub-question is also addressed more broadly through a statistical analysis of mitigation ratios used for temporary vs. permanent impacts and a statistical analysis of impact size, represented by two histograms of the size distribution.

The second sub-question is whether particular regions, habitat types, or mitigation strategies have been more or less successful at mitigating losses of ecological function. Answering this question involved using the performance criteria database to create a series of categorical summary tables, sorting the performance criteria success data by district, habitat type, mitigation type, criteria type, and number of years of monitoring completed. This study groups performance metrics into five categories: vegetation, hydrology, soil/sediment, wildlife, and administrative. Each metric type was assigned a metric subtype—so, for instance, vegetation sub-types include absolute vegetation cover (of specific strata or across all strata); native plant cover; non-native or invasive plant cover; California Rapid Assessment Method (CRAM) wetland survey scores; and other metrics such as species diversity, native plant dominance, species richness, recruitment of new species, and survival of planted or seeded vegetation. Each metric subtype corresponds to a series of criteria—so, for instance, a performance standard requiring 80% or greater native vegetation cover by the fifth monitoring year would fall under the Vegetation metric category and the Vegetation Cover subcategory.

The third sub-question investigates how thoroughly the Coastal Commission is monitoring permit compliance with regard to compensatory mitigation requirements. Are all the necessary monitoring documents available? Are files effectively transferred to a new staff member or central database when the lead analyst responsible for a given project leaves the agency? In order to evaluate monitoring thoroughness, the availability of mitigation plans and monitoring reports for 126 compensatory wetland and riparian mitigation projects, as determined through correspondence with Commission staff, were

systematically recorded in a spreadsheet. Then, individual projects were categorized by whether mitigation plans and/or monitoring reports were available and, if reports were not available, why. The Analysis and Findings section of this report includes a written characterization of various permits which are representative of particular gaps in the monitoring, reporting, and enforcement of mitigation requirements, with the aim of providing a clear, unbiased view of how thoroughly the Coastal Commission is addressing mitigation compliance.

In the process of maximizing limited data to investigate the above research questions, the full dataset was reduced at various points into overlapping subsets to facilitate analysis. For instance, this study compiled data from 25 permits to calculate net gain and average mitigation ratio, and used data from 13 permits to calculate the number of "noncompliant" acres. Some, but not all, of the permits in the set of 13 were also included in the set of 25; the reason is that permits or impacts for which acreage or ratio information was not readily available were not included in the subset used to calculate ratio and net gain. To address any potential confusion, the various analytical subsets of inquiry used are elucidated below in Table 2.

Table 2: Analytical Subsets of Inquiry

Analytical Subset	Permit Count	Impact Count	Criteria Count	Table(s) and Figure(s)
Total compensatory wetland mitigation projects available	126	N/A	N/A	Tables 3 - 12
Mitigation ratio and acreage analysis	25	37	N/A	Tables 3, 5, 6, 7
Noncompliant acreage	13	13	N/A	Table 4
Distribution of impact size (overall)	32	39	N/A	Figure 5
Distribution of impact size (<1 acre)	25	30	N/A	Figure 6
Performance criteria analysis	26	32	331	Tables 8 – 12; Figure 7

Source: Data compiled and analyses conducted by author

4. Analysis and Findings

4.1 Wetland Acreage

The first sub-question is whether there was a net loss or gain of wetland acreage in the California Coastal Zone over the study years. In total, there were 38.7 acres of wetlands impacted via 37 discrete "impacts" across the 25 permits for which monitoring reports and acreage data were available (Table 3). This impacted acreage was mitigated with 86.2 acres of compensatory mitigation as built—up from 83 acres as permitted, due to bonus acreage—for a net gain of 44.9 acres. Bonus acreage was rare, but typically occurred in projects which required concurrence between multiple agencies; for instance, if the Coastal Commission required 2.5 acres of mitigation, but another responsible agency (e.g. the California Department of Fish and Wildlife) required 2.8 acres, then the permittee would need to build 2.8 total acres of mitigation even though only 2.5 were required pursuant to the Coastal Commission permit. Given that only seven of the 25 compensatory mitigation projects had completed the full mitigation monitoring period by March 2020, we can only be certain of a net gain of 4.3 "completed" mitigation acres even though it is likely that many more acres of wetland acreage were created, restored, or enhanced over the study period.

Table 3: Net Gain of Wetland Acreage by Region for a Subset of 25 Projects

Region	Project Count	Acres Impacted	Required Acreage	Extra Acreage	Net Gain (permitted)	Net Gain (completed)
North Coast	9	14.87	45.28	1.36	30.66	0.72
North Central Coast	4	2.07	2.24	0.00	0.17	0.01
South Central Coast	1	0.89	0.89	1.18	0.29	0.29
South Coast	3	6.04	7.25	0.00	1.21	0.37
San Diego Coast	8	14.88	27.31	0.65	12.52	2.93
Total	25	38.7	83.0	3.2	44.9	4.3

Source: Data compiled by author using staff reports and monitoring reports for 25 permits. No monitoring reports were available for the Central Coast region.

It is important to note that this “net gain” of wetland acreage is only the reported gain from 25 projects, approximately one-fifth of the 126 compensatory wetland mitigation projects permitted in the Coastal Zone over the study period. Thus, these results only describe a subset of the overall mitigation acreage that was implemented in those years, and do not necessarily represent the net gain across all projects.

There were also 5.11 acres of impacts associated with “noncompliant” mitigation across 13 projects which were delayed or deemed unsuccessful (Table 4). Two of these projects—those which were only partially noncompliant—were included in the 25 projects examined for the “net gain” count, but the others were not included. This subset of 13 projects—about 10% of the 126 wetland mitigation projects permitted in the study period—was identified as “noncompliant” for largely administrative reasons, and it is possible that mitigation still occurred at some of the sites even if it was not reported. In any case, this missing data points to key monitoring gaps and suggests that the actual “net gain” of wetland acreage could be lower than reported by successful projects alone.

Table 4: Noncompliant Acreage by Region

Region	Permit Count	Noncompliant acres
North Coast	4	4.57 ac
North Central Coast	4	0.07 ac
South Central Coast	5	0.46 ac
South Coast	0	0 ac
San Diego Coast	0	0 ac
Total	13	5.11 ac

Source: Noncompliant projects identified by author based on personal correspondence with Coastal Commission staff members regarding project status and monitoring report availability. No monitoring reports were available for the Central Coast region.

In some “noncompliant” cases, the project was permitted, but the permittee never submitted monitoring reports (i.e., administrative noncompliance). In still other cases, Commission staff outright confirmed that the applicant did not comply. In one case, Coastal Development Permit No. 2-15-1354—a Caltrans bridge replacement project at Estero Americano Creek on the border of Marin and Sonoma Counties—the project was

permitted with mitigation requirements in March 2016, but the mitigation was subsequently held up in litigation even though Caltrans went forward with the bridge replacement. The Sonoma County staff report for the bridge replacement noted that the project would proceed regardless of whether the mitigation occurred (Emerson 2016), and Coastal Commission staff confirmed that no mitigation had occurred due to the lawsuit (Manna, J., September 10, 2019; Allen, P., October 24, 2019). The lawsuit was eventually decided in Caltrans' favor, with the mitigation tentatively expected to occur. In the largest "noncompliant" case, the Commission was unable to provide monitoring reports for the revegetation of 4.56 acres on a fill reuse site from prior wetland mitigation. The impacts were minor, and the habitat was low-quality, so the on-site, in-kind mitigation was proposed at a 1:1 ratio primarily for erosion control.

Of the total 38.75 acres of wetland impacts, 82.5% (31.96 ac) involved freshwater wetlands while 17.5% (6.79 ac) involved saltwater wetlands (Table 5). Although freshwater wetland impacts made up 82.5% of the overall acreage, they only constituted 63% of the overall impact count (i.e., 37). This suggests that impacts to freshwater wetlands may have been on average slightly larger than those to saltwater wetlands, at least within the subset of wetland impacts included in this analysis.

Table 5: Impacts to Freshwater vs. Saltwater Wetlands

Region	# Freshwater Impacts	Freshwater Area Impacted (ac)	# Saltwater Impacts	Saltwater Area Impacted (ac)	Total Acres Impacted
North Coast	10	11.82	5	3.05	14.87
North Central Coast	4	2.06	1	0.01	2.07
South Central Coast	1	0.89	0	0.00	0.89
South Coast	2	5.50	2	0.54	6.04
San Diego Coast	7	11.69	5	3.19	14.88
Total	24	31.96	13	6.79	38.75

Source: Data compiled by author using staff reports and monitoring reports for 25 permits

A calculation of mean mitigation ratios by mitigation type and impact longevity indicates that the mitigation ratios used for "permanent" impacts—loosely defined as

those which involve outright habitat destruction or last longer than a year—are on average substantially greater than the ratios for “temporary” impacts, which is to be expected (Tables 6 and 7). However, the permanent ratios are still lower than the 4:1 ratio which is officially used to mitigate permanent wetland impacts. This gap may be attributed partially to the small sample size. Given that this data represents less than a quarter of the 126 permits which required compensatory wetland mitigation in the study period, it is possible that that the mean ratio is skewed artificially low by the inclusion of several anomalous ratios. Skew notwithstanding, the data shows a mean ratio of 3.96:1 for habitat restoration, 3.58:1 for creation, and 2.56:1 for enhancement required as mitigation for permanent wetland impacts between 2012 and 2018 (Table 6).

Table 6: Mean Mitigation Ratios for Permanent Impacts by Mitigation Type

Mitigation Type	# Projects	Permanent Impacts	Mitigation Acreage	Mean Ratio
Restoration	6	4.04 ac	16.04 ac	3.9:1
Creation	8	5.64 ac	20.19 ac	3.6:1
Enhancement	7	6.57 ac	16.81 ac	2.6:1

Table 7: Mean Mitigation Ratios for Temporary Impacts by Mitigation Type

Mitigation Type	# Projects	Temporary Impacts	Mitigation Acreage	Mean Ratio
Restoration	5	6.73	6.81	1:1
Creation	2	0.45	1.29	2.9:1
Enhancement	2	0.33	0.41	1.3:1

Source: Data for both tables compiled from staff reports and monitoring reports for 25 permits

Project size is another significant variable in accounting for the gain and loss of wetland acreage. The acreage of habitat impacts subject to compensatory wetland mitigation varies widely from less than a tenth of an acre to more than ten acres. Thus, even though 77% of the mitigated wetland impacts evaluated by this study were smaller than an acre, those 30 impacts—across 25 projects—only made up 13% of the total acreage because a handful of large impacts are disproportionately represented in the overall mitigation acreage. The mean wetland impact size across 39 impacts from 32

permits (including several deemed “noncompliant”) was 1.4 acres, but the standard deviation was 3.17, with a range from 0.001 acres (44 square feet) to 16.9 acres (736,164 square feet). Figure 5 is a histogram representing this full range of impact sizes across all 32 permits. Figure 6 is a histogram representing the 30 impacts smaller than one acre (across 25 projects).

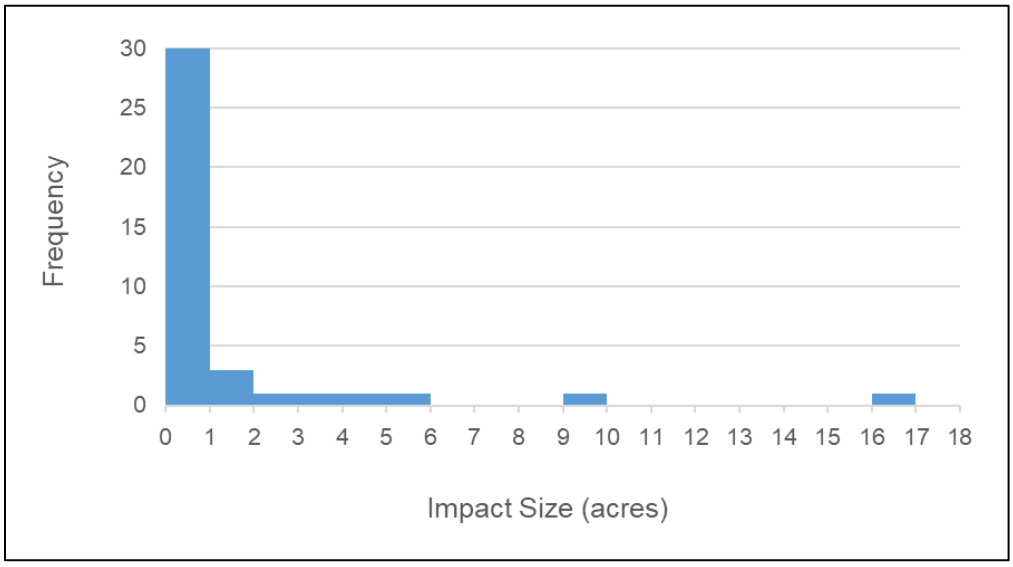

Figure 5: Distribution of Impact Size in 39 Impacts (32 Permits)

Source: Data compiled by author using staff reports and monitoring reports for 32 permits

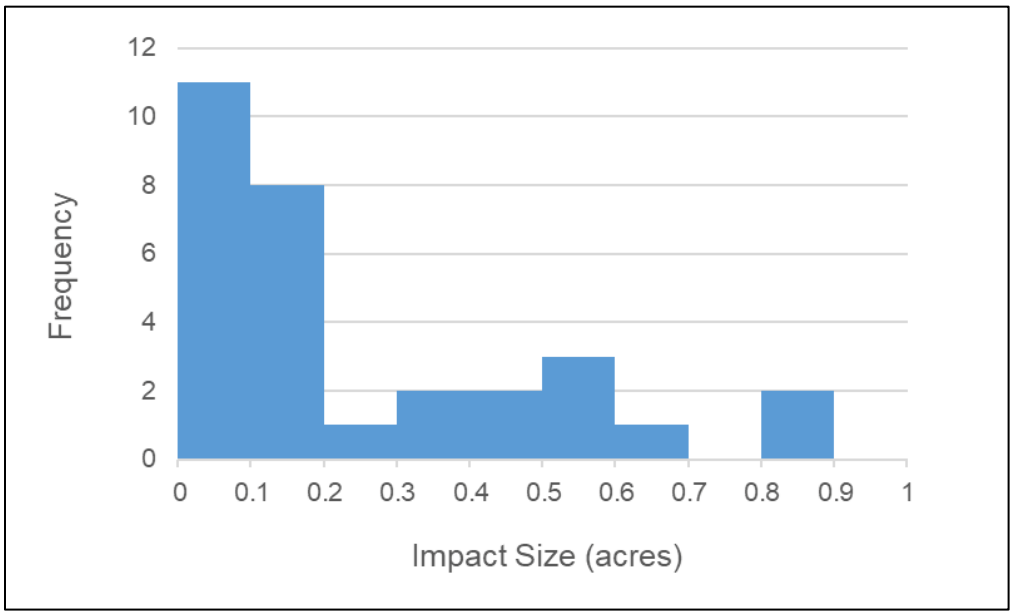

Figure 6: Distribution of Impact Size <1 Acre in 30 Impacts (25 Permits)

Source: Data compiled by author using staff reports and monitoring reports for 25 permits

Overall, the data indicates that the Coastal Commission's compensatory wetland mitigation practice resulted in a net gain of wetland acreage as permitted between 2012 and 2018. It also appears that mitigation ratios were generally consistent with the Commission's official standard—4:1 for permanent wetland impacts—for the subset of projects where final mitigation plans and monitoring reports were available, although ratios used for enhancement were lower than expected. Furthermore, it is notable that the vast majority of wetland impacts reviewed by this study were smaller than one acre, with a few much larger projects disproportionately represented in the overall mitigation acreage. However, these findings are limited by gaps in data availability. At least 13 projects—10% of the total permitted during the study period—were delayed or deemed unsuccessful, resulting in at least 5.11 acres of potentially unmitigated impacts. Even if some of these impacts were in fact addressed without monitoring, the presence of such gaps suggests that the overall ratio of impacts to mitigation acres may be lower than reported in the subset of well-documented projects. That said, given that the Commission has consistently chosen to use high mitigation ratios with the stated aim of compensating for the potential failure of mitigation efforts, one could argue that the subset of noncompliant projects is consistent with the agency's expectation that not all impacts will be restored. Regardless, these results should be taken as an incomplete view which suggests, but does not prove, a net gain.

4.2 Performance Criteria

The second sub-question is whether certain regions, habitat types, or mitigation strategies have been more or less successful at mitigating losses of ecological function. As noted in the Data and Methodology section, this study groups performance metrics into five categories—vegetation, hydrology, soil/sediment, wildlife, and administrative—each of which contains specific subtypes (Table 8). A vast majority (86.2%) of the performance criteria required were vegetation-related, including percent cover, CRAM wetland survey scores, species recruitment, and plant survival (Table 8). The next most common type was hydrology (7.5%), which includes such criteria as whether irrigation was required at the site and whether sustained inundation during the growing season consistent with wetland hydrology was observed. About 4% of criteria related to soil and

sediment, e.g. soil composition, contour, and erosion. The two least common types were wildlife (i.e. use of the site by certain wildlife species) and administrative (i.e. submission of photos and/or emails) metrics, each of which made up less than 1% of the total. These findings are consistent with other studies which found that success criteria were disproportionately focused on vegetation over other ecosystem metrics in compensatory wetland mitigation elsewhere in California and the U.S.

Table 8: Distribution of Performance Criteria by Metric Type

Metric Type	Count	Proportion
Vegetation	287	86.2%
Hydrology	25	7.5%
Soil/Sediment	13	3.9%
Wildlife	3	0.9%
Administrative	3	0.9%
Total	331	100%

Source: Data compiled by author using 26 mitigation monitoring reports submitted to CCC

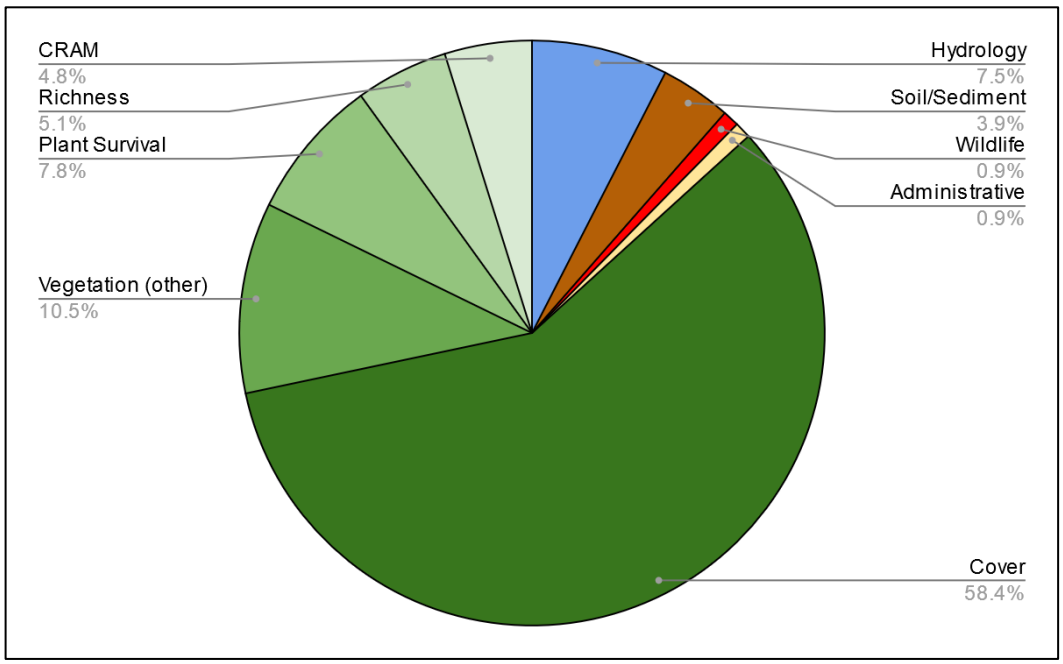

Figure 7: Most Common Success Criteria Types and Subtypes

Source: Data compiled by author using monitoring reports for 26 permits submitted to CCC

Figure 7 illustrates the most common types and subtypes of performance criteria. In the monitoring reports for 26 permits, 58.4% of criteria set goals for vegetation cover ranging from quantitative (e.g. 60% native cover) to qualitative (e.g. no large bare spots observed). See Appendix D: Performance Criteria Types and Subtypes for a table showing the distribution and success of performance criteria by type and subtype.

In the 26 projects for which monitoring data was available, only 58.3% of the performance criteria were met across all years of monitoring. One-fifth (20.2%) of the criteria were not reported, so no information was available regarding whether or not that subset was successful (Table 9). When limited to the most recent monitoring report submitted for each project, the success rate was slightly higher—with 64.8% of criteria deemed successful—and the percent of criteria not reported remained about one-fifth. Of the 26 projects, eight were in the first year of monitoring; five in the second year; six in the third year; two in the fourth year; four in the fifth year; and one was deemed complete with no years of monitoring after on-site reseeding for temporary impacts was confirmed via email. The mean success rate per project, taking into account only the most recent monitoring report for each project, was 67.4%. It is possible that some success criteria were fulfilled, but were not included in the monitoring report, in which case this average success rate would be higher than reported. The data currently available, however, indicates roughly a success rate of roughly two-thirds.

Table 9: Percent Criteria Met Across 26 Projects

Category	Overall Success Rate (All Years)	Overall Success Rate (Most Recent Year)	Average Per Project (Most Recent Year)
% Yes	58.3%	64.8%	67.4%
% No	21.5%	14.5%	14.8%
% No info	20.2%	20.7%	18.5%

Source: Data compiled by author using 26 mitigation monitoring reports submitted to CCC

Particular trouble spots included performance criteria requiring native vegetation cover (17.2% of all criteria; 43.9% successful; 17.5% not reported); species richness (4.2% of all criteria; 28.6% successful; 64.3% not reported); and vegetation survival

(7.8% of all criteria; 50% successful; 46.2% not reported). This is consistent with the findings of Matthews and Endress (2008), who found that many sites in their evaluation of Illinois wetland mitigation failed to meet plant survivorship and native species dominance criteria. In trying to explain why, they suggested that such criteria were generally too strict for permittees to achieve compliance within time and budget limits.

On the other hand, Matthews and Endress opined that certain types of success criteria, e.g. percent vegetation cover and percent hydrophyte cover, were so broadly framed that they were not meaningful measures of ecological function. To put this in practical terms, a site which is dominated by exotic plant species might have a high percent absolute vegetation cover, causing it to be deemed successful according to a "percent absolute cover" performance criterion even though the proportion of native species at the site is actually quite low. In compensatory wetland mitigation projects required in the Coastal Zone between 2012 and 2018, 20.8% of performance criteria were broad "overall vegetation cover" metrics; 72.5% of these were deemed successful across all years, while 17.5% were not reported. It is notable also that permittees reported an 80.3% success rate for performance criteria measuring invasive or non-native plant cover (19.9% of all criteria, 12.5% not reported). This data validates the conclusions of Matthews and Endress, but also suggests that "invasive plant cover" criteria—with a higher success rate than both "native cover" and "overall cover" criteria, but a lower rate of unreported criteria than "native cover" criteria—could be a less stringent but still not over-broad alternative.

Table 10: Success Rate and Standard Deviation of 32 Impacts (26 Projects) by Habitat Type in Most Recent Available Monitoring Report

Habitat Type	% Successful	Standard Deviation	Impact Count
Freshwater Wetland	68%	0.41%	5
Mudflat	100%	0.00%	2
Palustrine wetland	80%	0.33%	5
Riparian	80%	0.21%	7
Saltmarsh	47%	0.40%	13

Source: Data compiled by author using 26 mitigation monitoring reports submitted to CCC

Table 10, above, describes the reported success of performance criteria by habitat type in the most recent monitoring year available. In other words, this is the average, per habitat, of the percentage of performance criteria for each of 32 impacts (across 26 permits) which were deemed successful in the most recent year of monitoring—though, given that most projects were still in progress, not the final year of monitoring. Thus, if two out of three performance criteria for a given impact were recorded as having been met on the most recent monitoring report for that project, the success rate would be 67%. The five habitat types evaluated here are freshwater wetland, mudflat, palustrine wetland, riparian, and saltmarsh.

The data shows that saltmarsh impacts were the most common and were also mitigated the least successfully, with a 47% average success rate across 13 impacts. This may point to the difficulty of artificially simulating or restoring tidal wetland function as opposed to freshwater and non-tidal systems. Mitigation for mudflat impacts was deemed 100% successful, though this was the smallest sample with only two data points. It is notable that mudflat performance criteria focused on sediment composition and particle size rather than vegetation-based measures, making the mudflat mitigation different in scope from the other habitat types. Otherwise, mitigation for riparian impacts was the most consistently successful, with a success rate of 80% and a standard deviation of 0.21 across seven impacts.

Table 11: Performance Criteria Success Rate by Mitigation Type

Mitigation Type	# Permanent Impact Criteria	Perm Impact Success Rate	# Temporary Impact Criteria	Temp Impact Success Rate
Creation	38	60.5%	3	33.3%
Restoration	26	65.4%	11	81.8%
Enhancement	18	38.9%	1	100%

Source: Data compiled by author using 26 mitigation monitoring reports submitted to CCC

Table 11, above, evaluates the success of performance criteria by mitigation type—creation, restoration, or enhancement, separated into permanent and temporary impacts—in the most recent monitoring report available for each project. When

performance criteria success is analyzed by mitigation type, it appears that habitat restoration is on average somewhat more successful than creation or enhancement, although this finding may be skewed by the relative abundance of data for permanent impacts versus temporary impacts. Two other projects excluded from Table 10 involved "advance mitigation" designed to mitigate future impacts. In the advance mitigation projects, restoration was 69% successful (across 13 criteria) and enhancement was 68% successful (25 criteria) in the most recent year of monitoring available.

Although the data shows that the proportion of criteria met across all years varied widely by Coastal Zone district, this finding can most likely be attributed to the relative representation of each district in the dataset (Table 12). In other words, it is difficult to draw a meaningful conclusion about per-district success rates from this data because a disproportionate number of monitoring reports were available from the North Coast and San Diego district offices, while no reports were available from the Central Coast and just one was available from the South Central Coast. It is possible that other differences between districts—e.g., relative concentrations of wetland area, relative differences in development pressure, or differing involvement of local coastal programs—may play a role in influencing success rates. However, since there seems to be a strong correlation between percentage of criteria met, project count, and total criteria count per district, a more spatially comprehensive dataset would be necessary to meaningfully address the sub-question of per-district success rates. See Table 11, below, for per-district data.

Table 12: Success Rate of Performance Criteria by Coastal Zone District

District	Total Projects	Total Criteria	% Criteria Met
North Coast	9	101	50%
North Central Coast	4	28	71%
Central Coast	0	0	n/a
South Central Coast	1	1	100%
South Coast	4	20	80%
San Diego Coast	8	181	58%

Source: Data compiled by author using 26 mitigation monitoring reports submitted to CCC

This study found that across all years of monitoring in the study period, 12.4% of performance criteria—41 of 331—explicitly called for comparing survey data to a reference site. Within the subset of criteria where a reference site was mentioned, 95% used vegetation-based metrics. Only one project compared hydrology to a reference site: the habitat mitigation and monitoring plan for the Hallmark West mitigation site, a tidal saltmarsh in the San Diego Coast area, included a requirement for its vegetation reestablishment component that water quality should be within 15% of a reference site.

In conclusion, the majority of performance criteria were vegetation-related, and nearly 60% of all performance criteria set goals for vegetation cover. Hydrology was the next most common category, with relatively fewer criteria addressing soil, sediment, wildlife, and administrative metrics. The mean number of success criteria achieved per project, taking into account only the most recent monitoring report for each project, was 69.3%. Considering the data by habitat type, saltmarsh impacts were the most common and were also mitigated less successfully than freshwater wetland and riparian impacts. When performance criteria success is analyzed by mitigation type, the data indicates that habitat restoration is on average somewhat more successful than creation or enhancement, but the relatively small sample size dilutes the significance of this finding. Success rates by Coastal Zone district appeared to be primarily a function of relative representation in the data rather than differences in management practices.

4.3 Monitoring, Reporting, and Enforcement Gaps

The third sub-question is: how thoroughly is the Coastal Commission monitoring permit compliance? As described in the Data and Methodology section, addressing this question involved corresponding extensively with Commission staff in an effort to locate mitigation plans and monitoring reports for the compensatory mitigation requirements associated with a list of 126 coastal development permits. However, despite the general willingness of staff to support the project, this correspondence phase produced plans and monitoring reports for only 32 projects. There were several primary reasons for this.

First, there is a limiting factor inherent to the dataset: most of the mitigation reviewed was not yet complete. The initial goal of the project was to simply document the consistency of mitigation ratios assigned for various compensatory mitigation

projects, so the permit review began with 2018 and worked backward to 2012. Each mitigation project has a five-year monitoring period and is usually initiated after the impacts have occurred. Even the permitted project which incurred the mitigation might not break ground for months or years—if at all—after it is approved by the Commission. Therefore, it is unsurprising that the majority (18 of 25) of the compensatory mitigation projects reviewed were not yet all the way through the mandatory monitoring period. In order to address this limitation, the data has been structured such that each performance criterion for each monitoring year of each project is a unique record. This made it possible to analyze the success of in-progress mitigation on a per-year basis, and thereby to compare the monitoring reports available for the in-progress projects to the monitoring reports from comparable years of completed projects—bearing in mind that interim criteria typically do not carry the same weight as final criteria.

In some permits examined by this research, the mitigation project itself had not yet been started. For instance, CDP CCC-15-RO-01, an enforcement order approved in March 2015, required the active restoration and preservation of 24.6 acres of habitat, including 6.15 acres of wetlands at the Banning Ranch property in unincorporated Orange County (CCC 2015). However, Southern California Enforcement Supervisor Andrew Willis confirmed by email in December 2019 that the mitigation was still yet to begin until the removal of oil infrastructure occurred (Willis, A., December 19, 2019). Therefore, no monitoring reports were available.

In other cases, the mitigation may have been completed, but the applicant never submitted any monitoring reports. For instance, CDP 1-09-020-A2, approved in August 2014, required the City of Arcata to mitigate for 480 square feet of wetland fill by removing a culverted crossing, restoring 0.05 acres of on-site riparian habitat per Special Condition 15, and creating new wetland habitat at a 1.26:1 ratio per Special Condition 14 (CCC 2014). On September 30, 2014, the City submitted a final wetland mitigation plan (for the establishment of 594 square feet of wetlands) and a supplemental restoration monitoring plan (for the riparian habitat restoration). However, North Coast District Supervisor Cristin Kenyon confirmed via email that the City never submitted as-built plans or three years of required monitoring reports (Kenyon, C.,

January 21, 2020). Without the monitoring reports, there is no way for us to measure whether the mitigation was successful.

Another representative example is CDP 1-16-0122, a permit issued to the City of Arcata in October 2016 for construction work on the Humboldt Bay Trail, which outlined a variety of mitigation requirements including off-site estuarine wetland enhancement via invasive *Spartina alterniflora* removal (Special Condition 9), on-site riparian habitat restoration (Special Condition 14), rare plant mitigation (Special Condition 12), off-site palustrine wetland creation to be implemented by Caltrans (Special Condition 8), and 1:1 revegetation of temporary staging impacts (Special Condition 13). When contacted via email in January 2020 about the monitoring reports for this mitigation, North Coast District Supervisor Cristin Kenyon said that although the City had submitted as-built reports for Special Conditions 9, 12, and 14 indicating that the mitigation for those requirements had been implemented, no annual monitoring reports had been received for any of those conditions—and, furthermore, that the City had failed to submit a monitoring report for the temporary impacts pursuant to Special Condition 13. The Caltrans-led off-site palustrine wetland mitigation for Special Condition 8 had also fallen through due to an issue with the chosen site, so no reports were available for that condition. Kenyon said that because the permittee was the City of Arcata, a local government agency with which the Commission has an ongoing relationship, the Commission's enforcement of these mitigation requirements was more strategic—which is to say that there were other, higher-priority compliance issues with other City of Arcata permits which Commission staff chose to enforce in lieu of the mitigation requirements for CDP 1-16-0122. Kenyon described that she had seen that the vegetation subject to the temporary impacts had grown back, so she was confident that the mitigation requirement for Special Condition 13 had been satisfied even though there was no documentation to that effect (Kenyon, C., January 22, 2020).

Kenyon reached out again several weeks later to say that the record request had made her realize that the City of Arcata was behind on submitting the monitoring reports for Special Conditions 9, 12, and 14, prompting her to contact the City. She attached the newly-submitted first-year monitoring report for CDP 1-16-0122, making it possible to include that project in the analysis of performance criteria compliance (Kenyon, C.,

February 12, 2020). It is plausible that if Kenyon had not followed up on the project in support of this research, it would have taken the City much longer to submit the first-year monitoring report; indeed, it is possible that the City would never have submitted monitoring reports at all. This episode reveals the political and occasionally selective nature of permit enforcement, particularly when the permittee is another government agency. When Commission staff, already stretched thin, are faced with multiple competing enforcement objectives, it is no wonder that more urgent regulatory goals—e.g., negotiating with the City to accept stricter conditions for a project currently under consideration—can take priority over the longer-term, but still important, process of receiving and reviewing mitigation monitoring reports.

In other cases, it was impossible to confirm that the mitigation requirement for a given project had been fulfilled because the analyst originally responsible for handling the project had left the Commission in the intervening period. For instance, there was one permit, CDP 2-14-0214, which required the removal of debris as out-of-kind mitigation for mudflat impacts along Bolinas Lagoon in Marin County (CCC 2014). I had the file shipped from the Sacramento archives to the San Francisco office, where I reviewed all plans, reports, and correspondence for the project. The file revealed that the Commission staff planner responsible had agreed with the contact at the County that removing several creosote-soaked telephone poles from the shoreline would be sufficient mitigation for the impacts. However, the file contained no official confirmation that the mitigation had occurred, and the planner had since left the Commission to join another agency. When contacted by email, he confirmed that he had no records for that project and did not recall whether the mitigation was completed, though he did recall that he had agreed to the removal of creosote-soaked telephone poles (Lavine, E., January 24, 2020). The County contact did not reply when contacted. Thus, although it seems likely that the mitigation did in fact occur, it was not possible to definitively determine project success due to the lack of conclusive documentation. This episode also points to the role of staff turnover in exacerbating the unavailability of records. The Commission experiences high turnover among its planning staff, especially in expensive coastal cities, due in part to relatively low pay (Koteen, L., May 4, 2020).

In still other cases, it was impossible to locate mitigation and monitoring documents within a reasonable timeline because the needed reports were not readily accessible. Many of the older projects—particularly those permitted from 2012 to 2014—had been undertaken at a time when mitigation plans and monitoring reports were primarily submitted and maintained as physical copies. Although some of these files remained on hand at the Commission district offices, others had been shipped to the agency's archives in Sacramento. This introduced an element of lag because neither I nor the staff members with whom I corresponded could review these documents without first ordering the associated file from the archives and manually sifting through the various records aggregated therein. The need to meet research deadlines led to the decision to omit from this analysis certain projects for which it was not straightforward to obtain and review documentation.

Finally, it is notable that some instances, staff members were simply too busy to help track down the plans and monitoring reports needed for this analysis. Of the 126 permits identified as wetland and riparian mitigation projects, it was ultimately necessary to abandon 63 projects—fully half of the potential data—due to the difficulty of reaching staff. For instance, North Coast District Manager Melissa Kraemer said in an email that her district office was understaffed during the research period and that neither she nor the office's administrative staff had the time to track down certain physical files, let alone review them to determine whether mitigation had occurred (Kraemer, M., March 2, 2020). It is important to note that Kraemer and other staff members from the North Coast office were by and large very helpful, going out of their way to provide a number of mitigation documents for this research. Other staff members in other offices never responded to record requests despite multiple emails, or in some cases responded only after multiple weeks. This description of difficulties is intended not to cast blame upon any particular staff member or district office, but rather to highlight a key finding: the fact that it was so difficult to track down mitigation monitoring reports from only a few years prior points to the lack of a centralized storage location and indexing protocol for such documents. If all mitigation plans and monitoring reports were uploaded by default to a central location—and scanned into this repository, if not already digital—then it would be easy, in theory, to access and review records from past compensatory mitigation

projects. As is, with records unevenly distributed across physical and digital locations, sometimes retained only in the email inbox of a particular staff member who may or may not still be at the Commission, it is no wonder that no one knows whether the agency's compensatory mitigation practice is working.

Ultimately, it was necessary to omit a number of projects from the analysis of performance criteria success due to lagged mitigation, the inaccessibility of documents, circumstantial gaps in permit enforcement (i.e., where the permittee never submitted monitoring reports), and the unreliability inherent in asking busy staff members to help locate monitoring reports. The difficulty of obtaining these reports is in itself a significant finding because it reveals significant gaps in the reporting, enforcement, and indexing of compensatory mitigation requirements within the California Coastal Commission. Fortunately, where there are identifiable gaps, there are commensurate opportunities to develop new norms and protocols for improved accountability. The Conclusions and Recommendations section of this report addresses several of these opportunities.

5. Conclusions and Recommendations

This study evaluated the success of compensatory wetland mitigation permitted in the California Coastal Zone between 2012 and 2018. The question of success was investigated through three sub-questions: 1) Was there a net loss or gain of functional wetland acreage in the California Coastal Zone from the years 2012-2018?; 2) Are there particular districts, habitat types, or mitigation strategies that have been more or less successful at mitigating losses of ecological function?; and 3) How thoroughly is the Coastal Commission monitoring permit compliance?

5.1 Conclusions

The data and analysis indicate that the Commission's compensatory mitigation program resulted in a net gain of 44.9 wetland acres, as permitted, for 38 discrete habitat impacts across the 25 permits for which both monitoring reports and acreage data were available—about one-fifth of the total 126 compensatory wetland mitigation permits identified. Mitigation ratios were largely consistent with the Commission's custom of 4:1 for permanent wetland impacts. However, this study also identified 5.11 acres of impacts in 13 permits that were delayed or deemed unsuccessful, suggesting that the actual net gain could be lower than reported. Another significant finding is that even though 77% of the mitigated wetland impacts reviewed by this study were smaller than an acre, those 30 impacts only made up 13% of the total mitigation acreage because a handful of much larger impacts are disproportionately represented. Although this initial research suggests that the Commission is achieving "no net loss" based on the reported data, further research is needed to extend these findings to all wetland and riparian compensatory mitigation projects in the study period—and, if possible, to broaden the study period to include earlier projects—to perform a more comprehensive accounting of wetland acreage and function.

This study found that 86.2% of the performance criteria required for mitigation monitoring were vegetation-related, and 58.4% focused on vegetation cover. Hydrology was the next most common category, with fewer criteria addressing soil, sediment, wildlife, and administrative metrics. Only 12.4% of criteria involved comparison to a

reference site. About 65% of criteria across all projects were achieved in the most recent year of monitoring, with an average of 67.4% achieved per project. Saltmarsh impacts were the most common and were also mitigated less successfully than freshwater wetland and riparian impacts. This study found that habitat restoration was more successful on average than creation or enhancement, but the small sample size limits the significance of this finding. Success rates by region appeared to be primarily a function of relative representation in the data rather than differences in management practices. These findings are further limited by the fact that this study only indexed compensatory mitigation projects back to 2012, meaning that most of the projects had not yet undergone the full mitigation and monitoring period as of early 2020. Further research is needed to extend this dataset into the past to include pre-2012 permits.

The data-gathering phase of this study included an effort to locate mitigation plans and monitoring reports for compensatory wetland mitigation projects associated with 126 coastal development permits. However, despite extensive correspondence with staff over a period of months, it was only possible to obtain meaningful compliance data for a subset of 26 projects—one-fifth of the total permits identified. The reasons for unavailability included lagged mitigation, inconsistent record storage, circumstantial lapses in permit enforcement, and limited staff time. The difficulty of locating monitoring data is a significant finding because it reveals gaps in the reporting, enforcement, and indexing of compensatory mitigation requirements within the Commission. These gaps could be partially addressed through internal policy reforms to systematize the storage and review of mitigation monitoring records—see Recommendations.

After addressing the three sub-questions and evaluating a number of variables, there is still no straightforward answer to the question of whether the California Coastal Commission's compensatory wetland mitigation program is "successful". The program appears to be achieving a net gain of wetland acreage, as permitted, and appears to be following its own mitigation ratio guidelines in its requirements of permittees (if not necessarily in realization). However, mitigation success as reported by annual monitoring reports is mixed, and there is room to improve both the diversity and efficacy of mitigation performance criteria. Furthermore, this study found significant gaps in the

reporting, enforcement, and indexing of compliance, revealing opportunities to improve accountability through technical and programmatic reforms.

5.2 Recommendations

The following recommendations are intended to inform and improve future compensatory wetland mitigation required by the California Coastal Commission.

5.2.1 Diversify Performance Criteria

The first recommendation of this report is that the Commission's compensatory mitigation program could benefit from the inclusion of more diverse performance criteria in mitigation and monitoring plans. The overwhelming majority of performance criteria used for permits between 2012 and 2018 were vegetation-based metrics, with nearly 60% of criteria focused on surveying native, invasive, or overall vegetation cover (Table 8). However, other studies have suggested that including broader measures of ecological function (e.g. hydrology metrics, wildlife surveys, and soil sampling) can make mitigation monitoring more robust and lead to more thorough restoration of ecological function (Matthews and Endress 2008; WSDOT 2017; Sueltenfuss and Cooper 2019). In addition, the work of Craft and Hopple (2011) and others has suggested that the use of reference sites can be a powerful comparative tool for accurately gauging ecological function in compensatory wetland mitigation sites. Only 12.4% of performance criteria required in the study period used a reference site.

A technical framework for diversifying performance criteria already exists in the form of a 1995 report produced for the Commission entitled "Procedural Guidance for Evaluating Wetland Mitigation Projects in California's Coastal Zone" (Hymanson, Z.P. and Kingma-Rymek 1995). This report describes a diverse array of potential non-vegetation-based performance criteria with categories such as landscape (e.g. land use, watershed size); morphology (e.g. channel shape, wetland classification via aerial imagery); hydrology (e.g. hydroperiod, inundation, tidal prism water volume); water quality (e.g. salinity, pH, dissolved oxygen); substrate (e.g. soil depth, chemistry, percent composition); and fauna (e.g. species richness, density, abundance). The report

ranks each criterion by priority as either “most needed”, “desirable”, or “worthwhile”. A more diverse range of performance criteria in contemporary mitigation plans would likely include some of those criteria listed in the 1995 report, and the existing ranking system could be used as a basis for evaluating which to use for each project. The Commission should focus on identifying performance metrics that are meaningful, cost-effective, and practically feasible to implement so as to maximize the “return on investment” of mitigation monitoring and facilitate the inclusion of more diverse criteria.

5.2.2 Systematize Storage and Review of Monitoring Reports

The second recommendation of this report is that the Coastal Commission should consider implementing clearer protocols for the collection and management of mitigation monitoring reports in order to improve accountability—including the accountability of permittees to the Commission as well as the accountability of the Commission to the public. Monitoring data is currently not maintained in a consistent location and is not easily accessible even to the technical staff members with the most theoretical ownership over the data, making it difficult to account for habitat gains and losses from a programmatic perspective. This in turn presents a significant barrier to members of the public wishing to review data or file public record requests.

In terms of data storage, this recommendation might entail establishing a central database for storing mitigation plans and monitoring reports for each mitigation project, then incentivizing staff to make a habit of uploading these reports to the central database. The technical infrastructure is already largely in place: Commission staff members use an intranet drive (known as the “G Drive”) to store files for posterity and interdepartmental collaboration, and staff also sporadically upload permit data to the Coastal Data Management System (CDMS), a web-based data management platform adapted for the Commission’s use. However, the CDMS, which employs a nonintuitive user interface, appears to be only sporadically used and is not a convenient means of storing monitoring data. The “G Drive” is regularly used by staff, but did not contain most of the monitoring reports needed for this research, indicating that its use in the context of compensatory mitigation is inconsistent. A cost-effective remedy consistent with previous actions taken by the agency would be to extend the mandate of Action

5.3.3 of the Commission's 2013-2018 Strategic Plan, "Evaluate Options to Streamline Recorded Documents Protocols", in which guidance was provided to agency staff to improve efficiency in processing documents (CCC 2019). One component of such a database might be a notification reminding analysts and permittees to submit reports when they are due.

Furthermore, from an accountability perspective, it bears mention that mitigation monitoring data is public record. The Commission requires the submission of monitoring reports as part of its mandate to regulate development and protect natural resources and public access in the Coastal Zone. Staff reports, meeting records, and other technical documents are already made available to the public on the agency's website. As such, it stands to reason that mitigation monitoring reports and associated data should be available to the public for reference, whether summarized in annual status reports (i.e. a yearly "report card" for the compensatory mitigation program), made wholly available via a public data portal, or at least made accessible to public record request by explicitly mentioning mitigation records on the Commission's website.

5.2.3 Increase Agency Oversight of Reported Compliance

The third recommendation of this report is that the Coastal Commission should allocate more staff resources to validate permittees' reported compliance with compensatory mitigation requirements. Implementing this recommendation would involve creating more staff time for the careful review of mitigation monitoring reports, systematizing the scope and frequency of review, prioritizing the oversight of technical staff members, and increasing boots-on-the-ground engagement.

Systematizing the review of monitoring documents might entail encouraging or incentivizing coastal program analysts or technical staff to review the annual monitoring reports received for projects for which they are responsible. At present, there is scarce evidence that Commission staff are critically evaluating the annual progress of mitigation projects, which, if indeed the case, could disincentivize permittees from complying with performance criteria and could allow gaps in compliance to go unnoticed. It is also not clear whether all analysts possess the background or technical expertise to critically evaluate the monitoring reports they do review. The Commission's

technical staff reviews mitigation plans prior to approval because the specifications are highly technical in nature; accordingly, it might make sense for technical staff to also review monitoring reports. Without thorough oversight of mitigation success—including double-checking data, reviewing site photographs for evidence of compliance, and, where feasible, following up with site visits—the Commission could easily sign off on a mitigation project even if ecological function is not established at the site.

Permittees are responsible for submitting their own annual monitoring reports. These reports, and the photographs contained therein, are the primary means of determining whether a mitigation project is on a trajectory toward success. In some cases, the consultants hired to produce monitoring reports may be the same consultants responsible for site development. A 2001 report by members of the National Research Council's Committee on Mitigating Wetland Losses (Turner et al. 2001) suggested that permittees' self-interest in compliance reporting casts doubt on the accuracy of permittee-reported monitoring data. More direct review of mitigation progress—by Commission staff or an independent third party, either in person or using remote sensing techniques—for a greater proportion of projects would help validate the monitoring data submitted by permittees, bringing greater certainty to the question of whether the Commission's compensatory mitigation program is achieving success. This might entail conducting site visits at a random subset of mitigation sites or at a subset of sites identified as high-risk. Reviewers could be Commission technical staff, consultants hired by the Commission, or graduate students and/or faculty engaged through regional university partnerships.

If the compensatory mitigation monitoring requirement is to be a substantive regulatory implement rather than a mere procedural guideline, it is important to allocate more staff time to the careful review of monitoring reports. It is also essential to cultivate a greater degree of certainty regarding how closely permittee-reported compliance corresponds to on-the-ground conditions.

5.2.4 Clarify Accounting of Mitigation Acreage and Conditions

The fourth recommendation of this report is to encourage or require a clearer and rigorous description of mitigation acreage and conditions in the permit language. In

coastal development permits, mitigation requirements are usually described loosely in paragraph form, with few if any visual aids such as tables or maps. The maps that do exist usually do not specify the acreage of impacts and required mitigation. Thus, it is not always immediately apparent how many acres of mitigation are required or how exactly the mitigation activities correspond to the impacts. This is a particular issue with permits for complex projects with multiple impacts and/or a combination of several mitigation types. The issue is exacerbated by the reality that many compensatory mitigation requirements are conditional at the time the original permit is issued—pending the development of a final mitigation plan or the finding of significant impacts in a post-construction survey—and as such cannot always be described in precise detail in the permit language. Nonetheless, clarifying the relative acreage of habitat impacts and mitigation acreage, where practicable—or at least the required mitigation ratio, if more specific acreage cannot be provided at the time the permit is issued—could go a long way toward enhancing programmatic accountability on the project level.

Implementing this recommendation might entail issuing updated templates and stylistic guidelines to aid staff in the preparation of compensatory mitigation staff reports. Specifically, these guidelines could include basic templates for tables of impacts and mitigation acreage as well as boilerplate language for the summarization of mitigation requirements. A version of these guidelines could also be shared with permittees and consultants to aid in the production of clear mitigation plans and monitoring reports. Again, the issue is not that impacts and mitigation acreage are *never* described in sufficient detail—just that the inclusion of such detail is inconsistent on a project-to-project basis.

5.2.5 Further Study the Role of Off-Site Mitigation

The fifth recommendation of this report is that the Coastal Commission should study the possibility of expanding the role of off-site mitigation—for instance, via multi-permittee mitigation banking or regional-scale advance mitigation—as a tool for mitigating small, isolated impacts. This report found that the majority of compensatory wetland mitigation projects permitted by the Commission involve on-site mitigation for impacts less than half an acre in size. However, the average success rate across all

projects was less than 70% as reported. Given that larger mitigation projects tend to benefit from more thorough performance criteria, better funding, and greater staff oversight, there is a certain logic to the idea of mitigating small impacts off-site at regional “banks”. Under such a system, as long as mitigation acreage was properly accounted for, it might be more cost-effective for the Commission to ensure a consistent, high-quality mitigation standard. However, further research is needed to evaluate the feasibility of this option.

Mitigation banking already occurs in the Coastal Zone in the form of programmatic offsets and advance mitigation “credits” for statewide and regional infrastructure activities undertaken by permittees such as Caltrans and Southern California Edison. However, it is relatively rare for smaller projects unrelated to these large-scale infrastructure programs to be mitigated off-site in such banks.

There are risks to mitigation banking, and the existing level of use should not be expanded without careful consideration of the consequences. Stein et al. (2000) noted that the difficulty of accounting mitigation credits and assigning effective ratios has been a significant barrier to broader use of mitigation banking. Reiss et al. (2009) performed a review of 29 Florida wetland mitigation banks and found that while 83% were trending toward success, permit criteria were not based on ecological considerations, making it difficult to assess ecosystem function. Levrel et al. (2017) found that Florida mitigation banks experienced a gradual increase in the distance between impact sites and mitigation sites, exacerbating the localized loss of ecosystem services. Vaissière et al. (2017) found that mitigation banks achieved No Net Loss goals only within a limited “zone of economic-ecological viability”.

5.3 Next Steps

Ultimately, the California Coastal Commission and its staff will decide how to act upon these findings. One likely next step is to condense this report into a presentation for agency staff, and potentially for presentation to the body of commissioners. I have shared all data and findings with Commission staff, and have developed this report in close consultation with the agency’s Ecology Group, the team perhaps best equipped to apply these findings. Thus, this data will continue to be available as a resource for

future efforts to understand and improve the agency's compensatory mitigation practice. I plan to be involved in an ongoing collaboration with researchers at UC Santa Cruz to extend and further refine these findings.

In particular, further research is needed to extend these findings to all wetland and riparian compensatory mitigation projects in the study period—and, if possible, broaden the study period to include earlier projects—to determine the net acreage and overall success with greater certainty. Within the research timeline, it was only possible to locate mitigation monitoring reports for one-fifth of the total 126 wetland and riparian projects, but with more time it would theoretically be possible to obtain reports for at least half of the total projects. Specifically, filling in missing data for the 2012-2018 study period would require ordering all available mitigation plans and monitoring documents from the Commission archives, continuing to request files from busy staff members, and potentially traveling in person to certain district offices to review documents.

Further research is also needed to extend this dataset into the past to include older permits with a greater proportion of completed mitigation requirements. This next step would entail applying this study's methodology (Section 3a-3c, Appendix B) to reviewing the monthly agendas hosted at www.coastal.ca.gov/meetings/archive/#/ and cataloging compensatory mitigation permits issued in each month prior to January 2012. This could involve adding to the original database or creating a new dataset as needed. Since older compensatory mitigation projects are more likely to have been completed and undergone the full monitoring period, the inclusion of pre-2012 permits—perhaps even back to 1995, the oldest year for which permits are available online—could result in a much larger dataset, enabling more meaningful analysis of programmatic success.

Another avenue for further research is to apply this methodology to other habitat types for which compensatory mitigation is frequently required under the California Coastal Act. In addition to the 126 permits which required mitigation for wetland and riparian impacts, the initial data-gathering phase for this study found 212 additional permits which included 116 mitigated impacts to chaparral and coastal scrub, 141 potential marine and intertidal impacts, and a variety of other impacts to environmentally sensitive habitat (Appendix C). This data presents a ripe opportunity to better understand how and whether the Commission's compensatory mitigation practice is

succeeding at maintaining and restoring ecological function across various habitat types, not just wetlands.

The spreadsheet layout of the compensatory mitigation database created for this study may provide a guide for ongoing efforts to index and analyze past, present, and future compensatory mitigation projects. For this purpose, it may be pertinent to convert the database from its current spreadsheet format to a relational database program equipped with more sophisticated querying capabilities. A streamlined, centralized data management system for analysts to submit mitigation plans and monitoring data could auto-populate a database which would be accessible to the agency and the public.

The Commission might also find it useful to conduct a qualitative survey to determine how thoroughly analysts and technical staff are reviewing annual monitoring reports for compensatory mitigation projects. Although the coastal program analyst responsible for a particular project is theoretically also responsible for reviewing any compliance reports received, it is not clear how consistently—or how thoroughly—this is actually occurring. It is also not clear how many analysts possess the technical expertise to critically evaluate the monitoring reports they do review. Understanding more precisely how monitoring requirements compete for attention with more urgent permitting and enforcement goals would help inform actions taken to improve the review and storage of mitigation monitoring reports.

The study of compensatory mitigation as applied at the California Coastal Commission remains a nascent field of research with ample opportunities for further investigation. This report is just a first step. Insofar as this research may inspire more substantive monitoring requirements, more ecologically meaningful performance criteria, and better compliance outcomes, it has the potential to improve compensatory mitigation as a means of tracking and offsetting development-associated wetland impacts in the California Coastal Zone.

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Appendix A: List of Permits Reviewed

This appendix contains a table with basic information about the compensatory wetland mitigation projects reviewed for this research—specifically, the 26 for which monitoring reports were available.

Permit Year	Permit #	District Office	Permittee	Impacted Habitat Type	Monitoring Years
2012	1-11-007	North Coast	Union Pacific Railroad	Mudflat	4
2012	4-11-043	South Central Coast	City of Santa Barbara Parks and Recreation Department	Freshwater marsh	5
2012	5-10-106	South Coast	Caltrans District 12	Saltmarsh	1
2012	5-11-68	South Coast	Shea Homes	Saltmarsh, freshwater wetlands	1
2012	6-11-93	San Diego Coast	Caltrans	Riparian wetland	5
2012	A-1-MEN-09-34	North Coast	Michael Marr & Judith Malin	Freshwater wetland	5
2013	1-13-009	North Coast	Border Coast Regional Airport Authority	Palustrine emergent wetland, slough sedge marsh	4
2013	2-11-038	North Central Coast	Caltrans	Riparian willow	3
2014	2-13-0246	North Central Coast	Sonoma County Regional Parks District	Mudflat	2
2014	6-12-067	San Diego Coast	22nd District Agricultural Association	Saltmarsh	1
2014	6-14-0516	San Diego Coast	Plastino II, LP	Saltmarsh	3
2014	6-14-1589	San Diego Coast	Caltrans	Saltmarsh, riparian/marsh	2

2014	6-14-1707	San Diego Coast	Caltrans	Freshwater/brackish marsh	4
2014	A-1-DNC-12-021	North Coast	Elk Valley Rancheria	Palustrine forested wetland, riparian	1
2015	1-11-037-A1	North Coast	City of Eureka	Saltmarsh	6
2015	1-14-0820	North Coast	Border Coast Regional Airport Authority	Palustrine emergent wetland	3
2015	2-14-1612	North Central Coast	San Francisco Public Utilities Commission (SFPUC)	Freshwater marsh, riparian scrub	2
2015	5-15-0148	South Coast	Orange County Public Works	Saltmarsh (non-tidal)	1
2015	A-1-DNC-09-048-A1	North Coast	Border Coast Regional Airport Authority	Palustrine emergent wetland	3
2016	1-15-2054	North Coast	City of Eureka	Saltmarsh	2
2016	1-16-0122	North Coast	City of Arcata	Palustrine wetlands, riparian, saltmarsh	2
2016	2-15-1354	North Central Coast	Caltrans	Riparian willow	1
2016	6-15-0003	San Diego Coast	Bernardo Shores Project Owner, LLC	Saltmarsh	1
2016	6-15-1975	San Diego Coast	City of San Diego	Saltmarsh	1
2016	6-16-0108	San Diego Coast	San Diego Association of Governments	Riparian wetland	2

Appendix B: CDP Staff Report Structure

This appendix describes the methodology used to review California Coastal Commission staff reports when collecting data about compensatory mitigation projects. This guidance is designed to aid future researchers undertaking a similar pursuit.

Coastal Commission staff reports follow a generally consistent structure, though there are some stylistic differences between districts and over time. Unless there are any memoranda attached, the first (title) page contains basic contextualizing information about the project, including the name of the permittee, the location and description of the project, the filing and hearing date, and the staff recommendation to approve or deny the proposal. Next is the Summary of Staff Recommendation section, which briefly contextualizes the project and explains the staff members' reasoning for recommending approval or denial. This section also typically contains a paraphrased list of any special conditions imposed by the Commission.

Next is the table of contents followed by the motion and resolution, standard conditions, and special conditions. The motion and resolution and the standard conditions comprise mainly boilerplate language. The special conditions, however, provide valuable contextual information about the permittee's responsibilities for the project, including whether they must submit any restoration plans, monitoring reports, etc. that implement a compensatory mitigation requirement.

After the special conditions, the rest of the report largely consists of the Findings and Declarations, which comprises an array of technical subsections further supporting the staff recommendation. Findings and Declarations subsections are ordered by sequential letters (i.e. A, B, C...) and named according to their subject. Subsections A and B are typically "Project Description" and "Background" or "Permit History", respectively, but later subsections may describe such topics as "Environmentally Sensitive Habitat", "Biological Resources", "Public Access and Visual Resources", etc. The Findings and Declarations section is particularly useful for understanding the reasoning behind the mitigation ratios used in a particular project. There is also usually a subsection entitled "Standard of Review" or "Jurisdiction" which is useful for

determining whether the permit was evaluated for consistency with the Coastal Act, the policies of a Local Coastal Program (LCP), or both.

If the mitigation/monitoring plan was prepared in advance and submitted along with the permit application, it is often attached to the approved CDP as an appendix. Other common types of appendices include biological surveys, monitoring reports, and maps. Many permits are also supplemented by appendices in the form of associated plans, memos, and correspondence that contextualize the permit-shaping process.

The first objective upon examining each staff report was to determine whether the project, as conditioned, required compensatory mitigation to offset unavoidable impacts to a sensitive habitat area. If mitigation requirements are substantial and/or played a significant role in shaping the conditions, then they may be mentioned briefly in the project description on the first page of a staff report. If there was no evidence of mitigation on the first page, the next step was to skim the Summary of Staff Recommendation and the Special Conditions to look for conditions that clarified or fulfilled elements of a mitigation and/or monitoring plan, e.g. “Final Habitat Mitigation and Monitoring Plan”. In most cases, quickly reviewing these sections was sufficient to determine whether compensatory mitigation was required, although I sometimes needed to dig deeper into a staff report to find evidence of mitigation. If it could be determined that compensatory mitigation was required, then I catalogued the project in a spreadsheet, aggregating various details about the scope of the mitigation requirement and the reasoning behind it.

If compensatory mitigation will be undertaken off-site or will constitute a significant impact in its own right—for instance, large-scale, off-site habitat creation which involves substantial regrading to establish wetland hydrology—then the applicant typically must obtain a separate coastal development permit for the mitigation itself. This is also common for projects with multiple phases, or where a permittee chooses to mitigate impacts from multiple projects in a single “mitigation bank”. Thus, in some cases, it was necessary to review multiple related permits in order to clarify the reasoning behind certain mitigation requirements.

Appendix C: Summary Tables for All Habitat Types

This appendix contains additional data tables describing the data from the original compensatory mitigation database, which includes all habitat types—not just wetlands.

Permits by District and County

The tables on this page describe the 338 compensatory mitigation permits (for temporary, permanent, or potential impacts to all habitat types) issued by the Coastal Commission from 2012 to 2018, listed by district, county, and habitat quality.

District	Permits per District
San Diego Coast	55
South Coast	135
South Central Coast	56
Central Coast	30
North Central Coast	15
North Coast	47
SUM	338

County	Permits per County
San Diego	55
Orange	88
Los Angeles	79
Ventura	7
Santa Barbara	19
San Luis Obispo	10
Monterey	17
Santa Cruz	1
San Mateo	4
San Francisco	1
Marin	5.5
Sonoma	3.5
Mendocino	9
Humboldt	30
Del Norte	9

Habitat Quality	Count	Impacts TBD	Degraded
ESHA	319	104	14
Non-ESHA	22	2	5

Permits by Habitat Type

This table describes the number of compensatory mitigation permits (for temporary, permanent, or potential impacts) issued per habitat type within the California Coastal Zone from 2012 to 2018.

Habitat Type	Number of permits with mitigated or potential impacts
Wetlands (tidal)	45
Wetlands (freshwater)	56
Riparian	53
Oak woodland	23
Chaparral	39
Coastal sage scrub	62
Bluff scrub	12
Coastal strand	1
Coyote brush	2
Coastal dune	20
Coastal prairie	7
Eelgrass	110
Intertidal	2
Open water	6
Benthic	27
Redwood forest	2
Upland ESHA	23
Tree ESHA	6
Trees (non-ESHA)	7
Avian species	9

Appendix D: Performance Criteria Types and Subtypes

Metric Type	Metric Subtype	% of Total	Success Rate	# Not Reported
Administrative	Photos	0.6%	100.0%	0
Administrative	Email confirmation	0.3%	100.0%	0
Hydrology	Inundation	2.4%	75.0%	0
Hydrology	Irrigation	1.5%	80.0%	1
Hydrology	Tidal cycle	0.3%	100.0%	0
Hydrology	Water quality (reference)	0.6%	100.0%	0
Hydrology	Wetland hydrology	2.7%	44.4%	1
Soil/Sediment	BMI biomass	0.6%	100.0%	0
Soil/Sediment	Composition	1.8%	33.3%	0
Soil/Sediment	Contour	0.6%	50.0%	1
Soil/Sediment	Erosion	0.3%	0.0%	0
Soil/Sediment	Particle size	0.6%	50.0%	1
Vegetation	Cover	20.8%	72.5%	6
Vegetation	Cover (invasive)	19.9%	80.3%	8
Vegetation	Cover (native)	17.2%	43.9%	10
Vegetation	Cover (reference site)	0.6%	50.0%	0
Vegetation	CRAM	0.6%	100.0%	0
Vegetation	CRAM (biotic structure)	0.6%	0.0%	2
Vegetation	CRAM (overall AA)	1.8%	83.3%	1
Vegetation	CRAM (reestablishment)	0.6%	100.0%	0
Vegetation	CRAM (reference site)	0.6%	0.0%	0
Vegetation	CRAM (rehabilitation)	0.6%	100.0%	0
Vegetation	Density	2.4%	0.0%	4
Vegetation	Deviation	0.3%	100.0%	0
Vegetation	Diversity	2.1%	28.6%	0
Vegetation	Diversity (reference site)	0.6%	0.0%	2
Vegetation	Dominance	0.3%	0.0%	1
Vegetation	Frequency	1.2%	0.0%	0
Vegetation	Recruitment	3.0%	60.0%	4

Vegetation	Removal	0.6%	100.0%	0
Vegetation	Richness	4.2%	28.6%	9
Vegetation	Richness (native)	0.3%	0.0%	1
Vegetation	Richness (reference site)	0.6%	0.0%	2
Vegetation	Survival	7.8%	50.0%	12
Wildlife	Wildlife use	0.9%	0.0%	3